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ARTICLES AND RESEARCH REPORTS ON SCIENCE

ELECTRICAL ASSESSMENT OF AQUIFERS IN THE BASEMENT COMPLEX OF UNILORIN: IMPLICATIONS FOR EXISTING BOREHOLES

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Abstract

Schlumberger 4-electrode array was employed to sound 21 stations. IPI2WIN and surfer12 softwares were used to infer lithological series, aquifer thickness and depth. The aquifer hydraulic conductivity K and transmissivity T were calculated from the VES data using the Dar Zarouk principles. The field curves show that the area has 3 and 4 geo-electric layers. The layers were interpreted as the topsoil (130- 1469 Ωm), clayey (wet to dry) (52.6- 8552 Ωm), weathered/fractured basement (46.2-249 Ωm) and fresh basement (454-5022 Ωm) respectively. The aquiferious zones lie within the second and third layers. The aquifer depth is between 6.17 m and 24.9 m while the thickness ranges from 1.89 to 22.7 m. The longitudinal conductance S ranges from 0.02 to 0.468 $\Omega^{-1}$and transmissivity T varies from 246 to 2419.8 Ωm^2. The results conformed with the functional boreholes, such as at VES 3, sited in areas with maximum aquifers and highest transmissivity T. The NE and NW parts were found most suitable for fresh water exploitations. Low longitudinal conductance which implies low protective cover, in the vicinity of the borehole near VES 6 suggests the contamination claim of its water.

Keywords: Aquifer, Borehole, Hydraulic Conductivity and Transmissivity

Introduction

Water is a key ingredient supporting food production, sanitation, human livelihoods as well as ensuring continuity and functioning of ecosystem. In fact, it could dictate the pace of human settlement, agricultural and industrial developments of any society. In the same vein, Humaira and Jose (2009) stated that establishment of any human settlement is usually centered on available source of water and that, in modern days, issue of water supply has taken prominences in global matters. A basement complex terrain, the major sources of good water in the studied area include surface water (river) and groundwater. These are exploited through an embankment dam and drilled boreholes. Groundwater is considered of high quality as it is naturally filtered while percolating through the subsurface layers of the earth. In addition, the distribution problem associated with surface water is of no consequence with respect to groundwater as it is available virtually anywhere in the subsurface, though with variable quantity in the rock pores (Olatunji & Osazuwa, 2012).

Litho logical unit that are adequately permeable to allow water to be abstracted in sufficient volume is called an aquifer. Aquifer water is usually contained within cracks, fractures and pore spaces of soil, sediment and rocks and as a result, they have a high degree of unpredictability. Efficiency and yield of aquifers are determined by the way in which groundwater flows through the strata and the way in which water is released from storage within the strata. This makes accurately describing the hydraulic characteristic of an aquifer difficult. Indirect measurements of aquifer water levels can be used to determine the direction of groundwater flow, to measure aquifer hydraulic characteristics and understand its interactions (Olatunji & Musa, 2013).

Electrical resistivity survey has been found useful in delineating the lateral and vertical limits of the diastrophic features like faults, fractures, joints and shears and delimit the extent and thickness of the weathered basement (Olorunfemi & Oloruniwo, 1985; Olorunfemi & Olayinka 1992). In spite of the associated problems with basement rock aquifers, Azeez (1972) emphasized that considerable water could be available in the area, though occurrence might be erratic, partly because of the discontinuous nature of the groundwater source and this could also be attributed to well sitting by intuition.

To avoid failures, Coker, Akujieze and Oteze 2003 reiterated the use of appropriate exploration techniques to delineate the subsurface water-bearing formations. Ward (1990) stated that VES is excellent for vertical resolution. Zohdy, Eaton, and Mabey (1974) emphasized that VES has easy field logistics and economical. Hence, the VES survey was employed to investigate the aquifer for predicting the sustainability of some existing boreholes (Table 1) and to establish the viability of any proposed boreholes in the area. To achieve this aim the following parameters were obtained: depth and thickness of the potential aquifers, their hydraulic characteristics, and the apparent resistivity of subsurface areas beside some existing boreholes in order to study the yield of the boreholes and identify the litho logical sequence around them.

Hydrology and Location of the Study Area

Permeability is the ability of a rock or unconsolidated sediment, to transmit or pass water through it (Garg, 2005). It is measured by the coefficient of permeability or as hydraulic conductivity. Transmissivity is another physical concept of describing groundwater flow. It has a mathematical relation (discussed later) with permeability.

The two main types of aquifer in this area are the weathered basement and fractured basement aquifers with the latter usually occurring below the former. The aquifers are usually localized and disconnected but occur essentially as unconfined to semi-confined under water table conditions. The crystalline nature of the basement rocks precludes development of porosity and permeability necessary for good groundwater occurrence. Diédhiou, Cissé Faye, Diouf, Faye and Wohnlich (2014) asserted that appreciable porosity and permeability may have been developed within these rocks through fracturing and weathering processes. Olorunfemi, Dan-Hassan and Ojo (1995) envisaged for granites and gneisses, higher storage capacities and higher groundwater potentials if they are well fractured and possess significant porosities because of their mineralogy. There is always very high degree of weathering of the primary rock forming minerals e.g. feldspars and the ferromagnetic minerals into secondary clay and iron oxides respectively (Durotoye, 1983). However boreholes, which penetrate the weathered basement aquifers, have lower yields than those which penetrate both the weathered and fractured basement aquifers (Olorunfemi & Fasuyi, 1993).

The study area lies between longitudes 04°37′ 12′′ E and 04°40′ 47.52′′ E and latitudes 08° 27′ 1.44′′ N and 08°29′ 32.64′′ N. (Figure 1). The 21 boreholes assessed are distributed over 17.8 km^2 area within the campus as shown in Figure 1 and their location details are in Table 1.

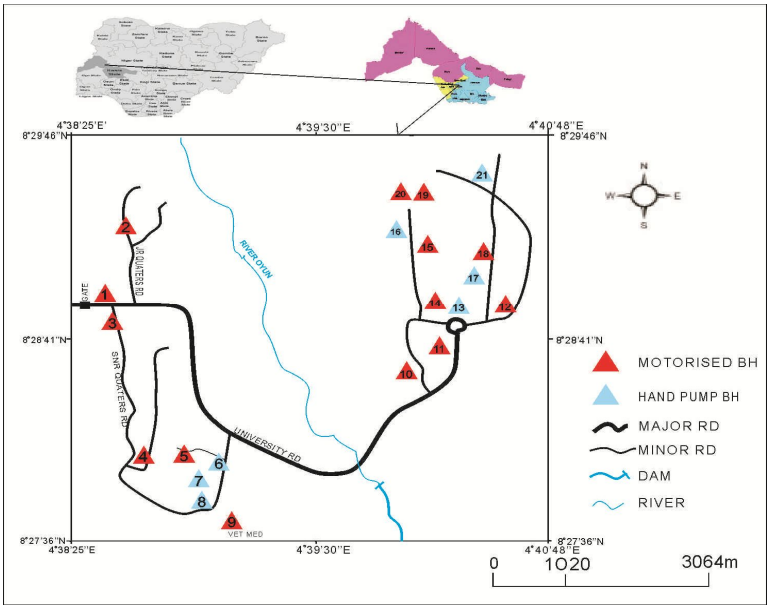

Figure 1: Locations of the Boreholes Surveyed

Table 1: Minutiae of the assessed boreholes

S/N	Location	Pumping Mode	Functionality	Remarks
1	Unilorin Garden		Not functional	Under Construction
2	Jalala Estate	Motorized	Functional	Good Yield
3	Unilorin Water Factory	Motorized	Functional	Very good yield
4	Pro-Chancellors Lodge	Motorized	Functional	Fair Yield
5	Primary School	Motorized	Not functional	In bad state
6	Adjacent Road to Primary School	Hand pump	Functional	Banned for consumption due to lead contaminant
7	Adjacent Road to Primary School	Hand pump	Functional	Good Yield
8	Adjacent Road to Primary School	Hand pump	Not functional	In bad state
9	Faculty of Vet Medicine	Motorized	Functional	Good Yield
10	Sports Field	Motorized	Not functional	In bad state
11	Central Mosque	Motorized	Functional	Good Yield
12	Beside Cooperative	Motorized	Functional	Good Yield
13	Between Senate Building & Block1	Hand Pump	Functional	Very good Yield
14	Behind Village I	Motorized	Not functional	Under Construction
15	Behind Village II	Motorized	Not functional	In bad state
16	Adjacent SUB	Hand pump	Not functional	In bad state
17	Adjacent Block 8	Hand pump	Not functional	In bad state

18	Adjacent Block 10	Motorized	Functional	Good Yield
19	Behind Abuja Hostel	Motorized	Functional	Good Yield
20	Behind Abuja Hostel	Motorized	Not functional	Under Construction
21	Trunil Hostel	Hand pump	Functional	Good Yield

Climate, Drainage and Localised Geology of the Area

The area is noted for two main seasons: rainy season that usually starts around April and last for the next 6 months, and dry season which spans for the next 6 months at the end of the rainy season. In between this period is the harmattan which is characterized by high temperature and dusty atmosphere (McCurry, 1976). The annual rainfall in the region is about 1252 ± 239 mm (Ejieji, 2004). The humidity ranges between 60 to 89% and the mean annual temperature is about 27.7°C with the maximum mean at 32.2° occurring from February to April (Iloeje, 1980); (Omotoso, Ojo, Morakinyo & Alao, 2012).

The drainage pattern in the study area is generally dendritic. The area is drained by both surface water and groundwater. The surface water is river Oyun. Discharging throughout the year, river Oyun flows in the southeast-northwestern direction (Olasunkanmi, Olatunji, Akoshile & Nwankwo, 2012) and out of the study area.

Nigeria is made up of three major litho-petrological components, namely, the Basement Complex [Pan-African and older (Precambrian) > 600 Ma], Younger Granites [(Jurassic) 200 – 145 Ma] and Sedimentary Basins [(Cretaceous to Recent) < 145 Ma]. The study area is mainly underlain by crystalline rocks, collectively referred to as the southwestern Nigeria Basement Complex (Fig. 2). The Basement complex is a polycyclic terrain which suffered its most pronounced deformation and mobilization during the Pan-African age (600 ma). Different ages have been ascribed to the Nigerian Basement Complex, but Grant (1969) and (1970) observed that the majority of the radiometric ages obtained fall in the range of 600 ma, which corresponds to the Pan-African thermo-tectonic event.

Based on the structural, lithostratigraghy and geochemical data the Precambrian rocks of Nigerian are classified into the following age groups, corresponding to the major Orogenies that have punctuated the Precambrian history of Africa. It has been suggested that the major plutonic events; *viz*: Liberian (2,600 – 3,000 ma), Eburnean (2,000 - 2,400ma) and pan-African (450 – 750 ma) did take place, resulting in what is now known as the Basement Complex of Nigeria. According to Elueze (1992), the three principal recognizable subdivisions within the basement complex are: the migmatite gneiss complex which is 60% of the surface area of the Nigerian basement complex (Rahman, 1988), Schist belts, and the Pan African plutonic series, which make up 20% of the basement complex in the southwestern part of Nigeria (Harper, Sherrer, McCurry & Wright, 1973).

The crystalline basement complex of the study area consists of gneisses and migmatities, schists, quartzites, Pan-African granite, late-stage minor pegmatitic and aplitic intrusives. Ilorin is situated within the Basement Complex rocks of granitic and metamorphic origin (Olasehinde, Virbka and Esan, 1998). These rocks represent the deeper, fractured aquifer which partly lies on top of a shallow, porous aquifer within the lateritic soil cover (Annor and Olasehinde, 1996). The rock units form part of the regional South Western highlands of Nigeria running NW-SE parallel to the River Niger (Offodile, 1987; Olasehinde *et al.*, 1998).

The superficial deposit in the study area terrain varies in thickness from 4 to 8 m is made up of dark sandy and clayey-loamy topsoil, usually less than 2 m thick, followed by laterite red soils, in most cases. The subsurface comprises the weathered, slightly weathered and fractured or fresh crystalline basement rocks. The oldest rocks in the area comprise gneiss complex whose principal member is biotite-hornblende gneiss with intercalated amphibolites. This underlies,

over half of the area. Other rock types are the migmatite, granite, granite-gneiss and schist. Outcrops are rare except for a few laterite capping the bedrock. The laterite consists of different horizons with distinct petrographic characteristics which may have significant influence on the shape of the VES curves. The surface terrain is fairly uniform permitting easy stretch of the Schlumberger array.

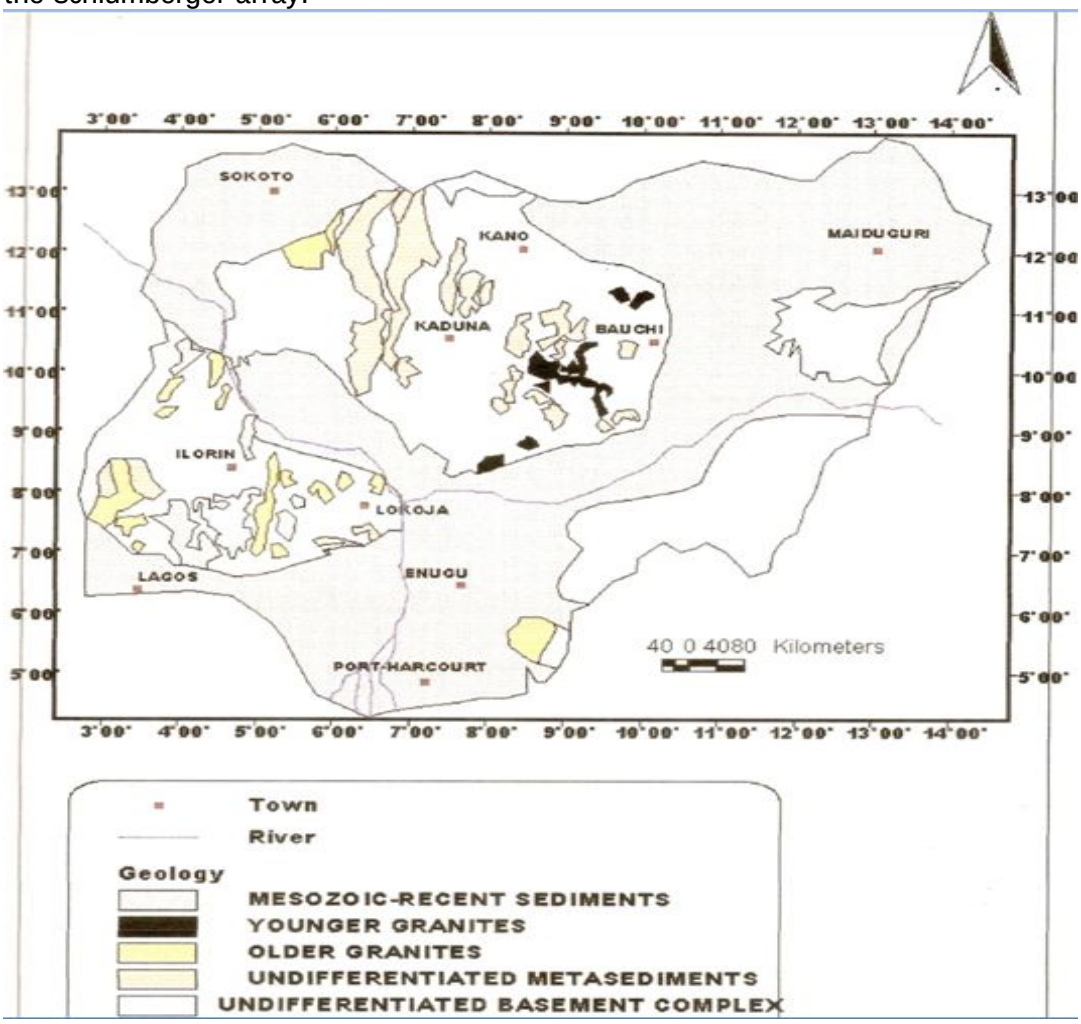

Figure 2: Geology of Nigeria
Source: Oyawoye, 1972

Material and Methods

Terrameter was used to monitor vertical variation of resistivity following Schlumberger 4-electrode Vertical Electrical Sounding (VES) technique. A VES point was located near each of the existing boreholes in the area (Fig. 1). The fieldwork was accomplished in April, around the driest period of the year in the area. The resistivity data was used to estimate the aquifer hydraulic characteristics such as hydraulic conductivity, K and transmissivity, Tvia the Dar Zarrouk concept.

The electrical resistivity method is an active geophysical method, employing an artificial energy source which is introduced into the ground through a pair of electrodes (Fig. 3). The procedure involves measurement of potential difference created in the vicinity of current flow. Based on

the first Ohm's law the total potential at the first current electrode due to the two current electrodes is determined and the same is done for the second potential electrode. Then, potential difference between the two potential electrodes is determined. Hence, based on the second Ohm's law apparent resistivity is calculated for each location of the current electrodes. The same calculations are done for each current position as the current electrode positions are expanded in steps.

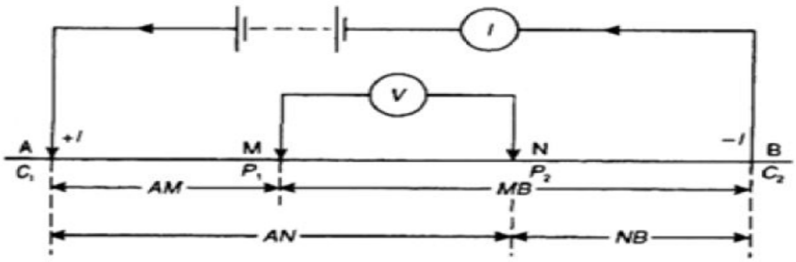

Figure 3: VES Electrode Configuration

The fundamental equation to get apparent resistivity is derived from Ohm's law; that is

$$V = IR \qquad Eq.1.$$

and

$$R = \frac{\rho L}{A} \qquad Eq.2.$$

where R is the electrical resistance, ρ is electrical resistivity, A is cross sectional area, and L is the length of the conductor.

The equipotential surface set up by the current flowing into the subsurface rocks is semispherical. So the area *A* in Eq. 2 could be that of a semi-sphere. Thus, the electric potential *V* at any point at a distance r from a surface point electrode emitting an electric current I in an infinite homogenous and isotropic semispherical medium of resistivity ρ could be written as

$$V = \frac{\rho I}{2\pi r} \qquad Eq.3.$$

The resistivity is considered constant in a homogenous and isotropic ground. However, it varies with the relative positions of electrodes in the presence of subsurface in-homogeneities and any computed value is known as the apparent resistivity ρ_a, given by

$$\rho_a = \frac{\Delta V}{I}(2\pi r) \qquad Eq.4.$$

So, for the Schlumberger technique used here (Fig. 3) the geometric factor G is thus given as:

$$G = \pi \frac{[(\frac{AB}{2})^2 - (\frac{MN}{2})^2]}{2(\frac{MN}{2})^2} \qquad Eq.5.$$

That is

$$\rho_a = \pi \frac{\Delta V}{I} \times G = R \times G \qquad Eq.6.$$

The resistance obtained from current and potential difference data at a given electrode spacing is applied in Eq. 6 to compute the apparent resistivity at that point. In this way, VES data at each sounding stations were computed and recorded.

Dar - Zarrouk procedure was followed to derive a formula in determining layer parameters. In doing this a unit square cross sectional area in a vertical direction is assumed, So, for horizontal aquifer layer, Dar-Zarrouk parameter, 'longitudinal conductance' (S) is equal to layer thickness over the layer resistivity (Maillet, 1947).

$$S = \frac{h}{\rho} = h\sigma \qquad Eq.7.$$

To obtain a layer parameter, a unit square cross sectional area is cut out of the aquifer layers of infinite lateral extent. The transverse resistance, R, is given by:

$$R = h\rho \qquad Eq.8.$$

where σ is the electrical conductivity, which is analogous to the hydraulic conductivity K of the layer, S is the longitudinal conductance which is analogous to layer transmissivity T and h is the thickness of the layer. R and S are calledDar Zarrouk parameter, which have been shown to be powerful interpretational aids in groundwater surveys (Zohdy *et al*, 1974).

When the variations in effective porosity controls the groundwater flow as in an unconsolidated, sandy, clay-free aquifer, a direct relationship would be expected between hydraulic conductivity and porosity (i.e. K proportional to Φ), while an inverse relationship would be expected between porosity and resistivity (i.e. Φ proportional to 1/ρ). The factor controlling the relationship between hydraulic conductivity and resistivity changes with clay content as in a clay –rich aquifer. A direct relationship could be observed. Thus

K α 1/clay content

$$\frac{K}{\rho} = C \qquad Eq.9.$$

where, K and ρ are hydrologic conductivity and formation resistivity, respectively.

Therefore, in clay-rich environments K/ρ should remain constant.

In a three-layer medium such as overburden above groundwater level, overburden below water level and solid rock below overburden the longitudinal conductance is the dominant parameter for the middle layer, which has low resistivity. Therefore, the electrical current tends to flow parallel to the bedding controlling the shape of sounding curve (Keller & Frischnechk, 1979). Horizontal ground water flow through an aquifer is not governed by hydraulic conductivity alone, but also depends on the transmissivity (T), the parameter characterizes the ability of the aquifer to transmit water (Ekwe, Nnodu, Ugwumbah & Onwuka, 2010). Transmissivity is defined as the product of the saturated thickness of the aquifer (h) and the average value of the hydraulic conductivity (K);

$$T = Kh \qquad Eq.10.$$

K is the hydraulic conductivity of the aquifer layer with thickness *h*.

The hydraulic conductivity is proportional to the resistivity of the aquifer. This implies that in the absence of a pumping test data, the aquifer hydraulic conductivity K can be approximated to be the true resistivity of the aquifer derived from geoelectric investigation (Hubbard & Robin, 2002). Therefore,

$$T = Kh = \rho h \qquad Eq.11.$$

But the product of the a layer's resistivity and its thickness is the transverse resistance R (Eq. 8), which is numerically equal to the transmissivity (T), that is

$$T = R \qquad Eq.12.$$

Hence, an analytical relationship between transmissivity and longitudinal conductance has been suggested by Niwas and Singhal (1981) by combining Equations 7, 8 and 9we get

$$T = S(K\sigma); T = SC \qquad Eq.13.$$

Therefore, Eq. (13) offers a possibility of estimating transmissivites and hydraulic conductivities from the values of longitudinal conductance, once the nature of variation of products Kσ is known (Niwas & Singhal, 1981). It is also emphasized that in areas of similar geologic setting and water quality the product Kσ remains fairly constant. Thus, knowledge of K from some existing boreholes and of σ from VES sounding can be used to estimate Kσ for the same

geologic zone. This relationship forms the basis for the determination of aquifer hydraulic parameters used in this study.

Results and Discussions

The sounding data were analyzed with the IPI2WIN software to delineate the sub-surface layering as well as their depths, thickness and the resistivity values (Table.4.1). Sample field curves are shown in Figures 4 and 5; and others are summarized in Table 2. The area is mostly underlain by four and three geoelectric layers of various lithologies

Characteristics of the aquifers in the areas of the boreholes are summarized in the Table 3. The aquifer thickness ranges between 1.89 to 22.7 m. The aquifers in the area are categorized as thickest, thick and fairly thick as shown in Figure 6, the horizontal contour of the thicknesses, with VES 3, having the highest thickness of about 22.7 m. This is the location of the University sachet water factory. VES 10 coincides with the lowest aquifer thickness of 1.89 m. The aquifer unit in the area is the second or third geoelectric layer.

The depth to the aquifer ranges between 6.17 m and 24.9 m. The depth to the aquifer is shallow around VES 12, 13, 20 and 11 with an average depth of around 12.88 m. The deepest aquifers at about 24.9 m depth lie coincidentally around the location of the thickest aquifer. The thickest aquifer in the area appears suitable for the groundwater exploitation due to its greater depth (high volume of water) and is presumably free from sewage and surface contaminations. However, chemical analysis of the groundwater is still required to determine its suitability for consumption.

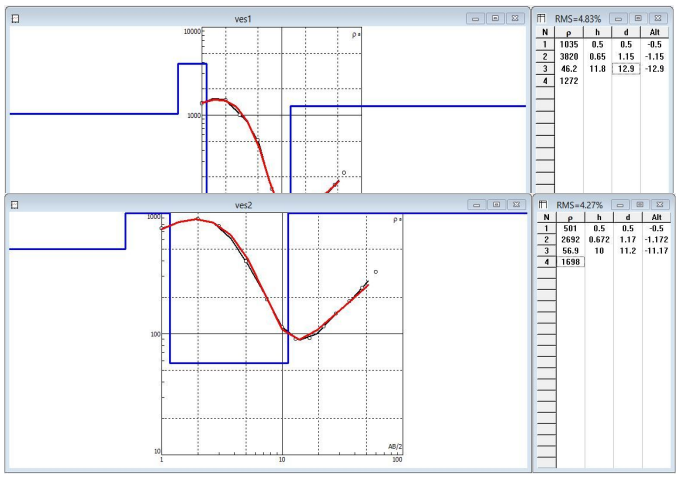

Fig. 5: Resistivity Curve for VES2

The litho logical series in the area are identified as shown in Table 2, based on the typical resistivity ranges for various rock suggested by Olatunji and Osazuwa (2012); Goodman (1989).

Table 2: Summary of the Geoelectric parameters obtained

VES	*Layers*	*ρ_a (Ωm)*	*Thickness h(m)*	*Inferred Litho logical Series*
1	4	1035, 820, 46.2, 1272	0.5, 0.7, 11.8	Lateritic top soil, Dry clayey sand, weathered or fractured basement, Fresh basement
2	4	501, 2692, 56.9, 1698	0.5, 0.672, 10	Top soil, Dry clayey sand, weathered or fractured basement, fresh basement
3	4	1563, 1921,	1.02, 1.18,	Lateritic top soil, dry clayey sand, weathered or fractured

		53.9, 454	22.7	basement, fresh basement
4	4	198, 75.9, 8552, 110	0.815, 1.91, 9.92	Top soil, clayey sand, dry clayey sand, weathered or fractured basement
5	3	1172, 127, 1461	1.08, 6.91	Lateritic top soil, weathered or fractured basement, fresh basement
6	4	398, 1387, 91.5, 542	0.5, 0.882, 7.27	Top soil, dry clayey sand, weathered or fractured basement, fresh basement
7	4	666, 414, 93.3, 842	0.5, 2.64, 13.3	Lateritic top soil, clay sand, weathered or fractured basement, fresh basement
8	4	880, 1992, 101, 528	0.699, 0.551, 7.8	Lateritic Top soil, dry clayey sand, weathered or fractured basement, fresh basement
9	3	872, 52.6, 197	1.11, 7.22	Lateritic top soil, clayey sand, weathered or fractured basement
10	4	604, 78.2, 1053, 629	1.46, 1.89, 17.8	Lateritic top soil, weathered or fractured basement, dry clayey sand, weathered or fractured basement
11	4	362, 1109, 38.5, 1216	0.5, 1.05, 6.39	Top soil, Lateritic soil, weathered or fractured basement, fresh basement
12	4	372, 881, 79, 768	0.5, 1.57, 4.1	Top soil, Lateritic soil, weathered or fractured basement, fresh basement
13	*4*	*325, 71, 25.3, 249*	*0.646, 4.21, 4.96*	*Top soil, clayey sand, weathered basement, fractured basement*
14	4	564, 1735, 98.7, 1893	1.22, 1.19, 18.7	Lateritic top soil, soil, dry clayey sand, weathered or fractured basement, fresh basement
15	4	290, 1047, 111, 832	0.923, 3.82, 21.8	Top soil, Lateritic soil, weathered or fractured basement, fresh basement
16	4	1469, 5974, 82.7, 2418	0.5, 0.822, 8.9	Lateritic Top soil, dry clayey sand, weathered or fractured basement, fresh basement
17	3	213, 36.5, 5022	1.55, 17.1	Top soil, weathered or fractured basement, fresh basement
18	4	235, 533, 46.2, 716	0.627, 1.45, 11.1	Top soil, Lateritic soil, weathered or fractured basement, fresh basement
19	3	447, 41.4, 1144	1.46, 6.72	Top soil, weathered or fractured basement, fresh basement
20	3	447, 24.9, 2276	1.87, 5.7	Top soil, weathered or fractured basement, fresh basement
21	4	130, 731, 46.8, 884	0.489, 0.734, 6.95	Top soil, Lateritic soil, weathered or fractured basement, fresh basement

Table 3: Aquifer Thickness and Depth as Inferred from Resistivity Data

VES	LONGITUDE	LATITUDE	ELEVATION	DEPTH (m)	THICKNESS (m)
1	004°38'21.4"	008°28'53.3"	326	12.9	11.8
2	004°38'28.9"	008°29'11.2"	329	11.2	10
3	004°38'27.3"	008°28'43.7"	336	24.9	22.7
4	004°38'43.6"	008°28'01.2"	365	12.6	9.92
5	004°38'58.2"	008°28'00.5"	331	7.99	6.91
6	004°39'03.4"	008°28'00.8"	318	8.65	7.27
7	004°39'00.4"	008°27'57.4"	333	16.4	13.3
8	004°39'00.5"	008°27'53.7"	325	9.05	7.8
9	004°39'04.5"	008°27'43.5"	351	8.33	7.22
10	004°40'06.9"	008°28'27.8"	349	21.1	1.89
11	004°40'19.0"	008°28'38.6"	363	7.94	6.39
12	004°40'38.3"	008°28'45.1"	351	6.17	4.1
13	004°40'25.0"	008°28'48.2"	362	9.81	5.64
14	004°40'18.3"	008°28'49"	353	21.1	18.7
15	004°40'14.3"	008°28'54.6"	349	26.5	21.8
16	004°40'07.5"	008°28'56.4"	344	10.2	8.9
17	004°40'26.5"	008°29'01.1"	383	18.6	17.1
18	004°40'28.8"	008°29'04.8"	371	13.2	11.1
19	004°40'10.3"	008°29'06.4"	336	8.18	6.72
20	004°40'10.5"	008°29'05.7"	336	7.57	5.7
21	004°40'30.7"	008°29'28"	382	8.17	6.95

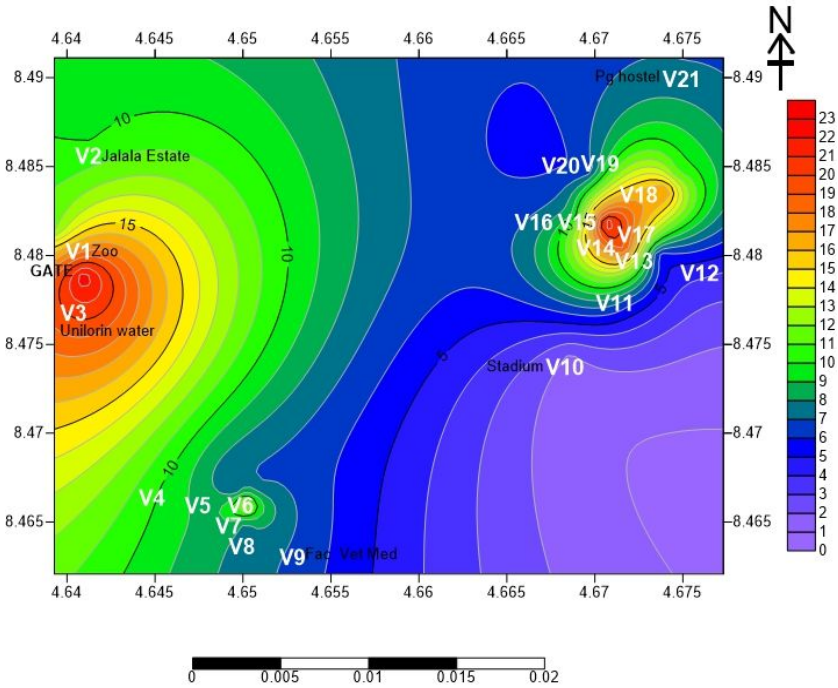

Fig. 6: Aquifer Thickness Map

The Dar-Zarrouk parameters obtained are shown in Table 4. Clayey overburden, which is characterized by relatively high longitudinal conductance, offers protection to the underlying aquifer. S values is used to classify areas into poor (<0.01 Ω^{-1}) , weak (0.01 - 0.1Ω^{-1}), moderate (0.1 - 0.2 Ω^{-1}), good (0.2 - 0.4 Ω^{-1}) and very good (>0.4 Ω^{-1}) protective capacity zones (Oladapo & Akintorinwa, 2007; Atakpo, 2013).

The longitudinal conductance (S) value varies from 0.02 to 0.468 Ω^{-1} in the study area with contour intervals of 0.02 Ω^{-1} (Fig. 6). The NW-SE trend is noted with low S values (0.02 to 0.1 Ω^{-1}), the highest values of 0.468 Ω^{-1} and 0.412 Ω^{-1} is oriented NE-SW, the locations of VES stations 3 and 17. High S values (> 0.2 Ω^{-1}) are observed at VES stations 1, 18 and 21. Elsewhere, the S value is moderate

The S-map (Fig. 7) revealed that 10% of the area depict very good protective capacity rating, 52% constitutes the good/moderate and 38% exhibits weak protective capacity. Oteri (1981) reported that an increase in S value may correspond to an increase in the clay content and therefore, a decrease in the transmissivity of the aquifer. Thus, moderate to high longitudinal conductance in the area envisages good aquifer protective capacity rating. Clayey/silty overburden in this part, which is characterized by relatively high longitudinal conductance, offers protection to the underlying aquifers. The longitudinal conductance value at VES 17 and 3 falls under very good protective capacity rating.

Table 4: Dar-Zarrouk Characterization Parameters

VES No	Aquifer Thickness h(m)	App. Resist. of Aquifer ρ_a (Ωm)	Transverse Resistance R=hρ (Ωm^2)	Longitudinal Conductance S =h/ρ (Ω^{-1})	Hydraulic Conductivity K (Ωm)	T = R (Ωm^2)
1	11.8	46.2	545.16	0.255	46.2	545.16
2	10	56.9	569	0.178	56.9	569
3	22.7	53.9	1223.53	0.421	53.9	1223.53
4	9.92	110	1091.2	0.09	110	1091.2
5	6.91	127	877.57	0.054	127	877.57
6	7.27	91.5	665.2	0.079	91.5	665.2
7	13.3	93.3	1240.9	0.143	93.3	1240.9
8	7.8	101	787.8	0.077	101	787.8
9	7.22	197	1422.3	0.037	197	1422.3
10	1.89	78.2	147.8	0.023	78.2	147.8
11	6.39	38.5	246	0.166	38.5	246
12	4.1	79	323.9	0.052	79	323.9
13	5.64	289	1629.9	0.02	289	1629.9
14	18.7	98.7	1845.7	0.189	98.7	1845.7
15	21.8	111	2419.8	0.196	111	2419.8
16	8.9	82.7	736	0.108	82.7	736
17	17.1	36.5	624.2	0.468	36.5	624.2
18	11.1	46.2	512.8	0.24	46.2	512.8
19	6.72	41.4	278.2	0.162	41.4	278.2
20	5.7	24.9	141.93	0.229	24.9	141.93
21	6.95	46.8	325.3	0.149	46.8	325.3

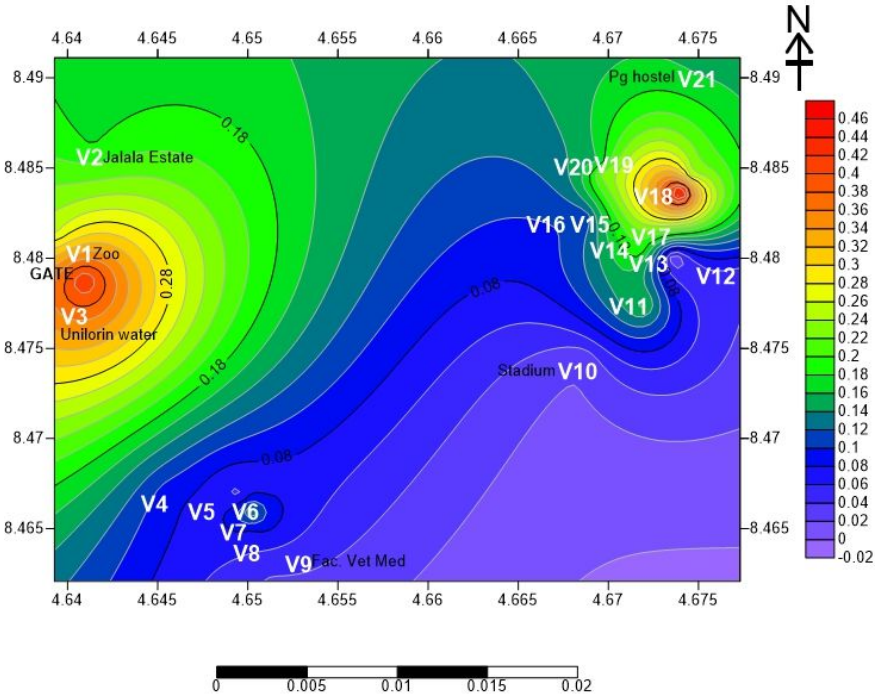

Fig. 7: Longitudinal Conductance Map

Further from Fig. 7, it can be surmised that the north-western and north-eastern part of the study area reflects very good to good protective capacity rating as can be envisaged from the high longitudinal conductance values. The low value of the protective capacity is a consequence of the absence of significant amount of clay as an overburden impermeable material in the south-eastern part thereby enhancing the percolation of contaminants into the aquifer. The

aquifers here may be prone to contaminations such as industrial and agricultural wastes, septic tanks and landfills, if located close to the sounding points. A prove of this is the contermination of borehole located at VES 6 whose S value is 0.08 Ω^{-1}.

The transmissivity (T) contour map with a contour interval of 100 Ωm^2 is shown in Fig. 7. The T value varies from a minimum of 246 Ωm^2 at VES 11 to a maximum of 2419.8 Ωm^2 at VES 15. It is evident from Fig. 8 that high T values (> 700 Ωm^2) are encompassing VES stations 3, 4, 5, 7, 8, 9, 13, 14, 15 and 16 in the study area, indicating fresh water zone. Increasing T values indicates fast recharge of water into aquifer after water is pumped out. The south-eastern and southern part of the study area is characterized by low T values, < 700 Ωm^2.

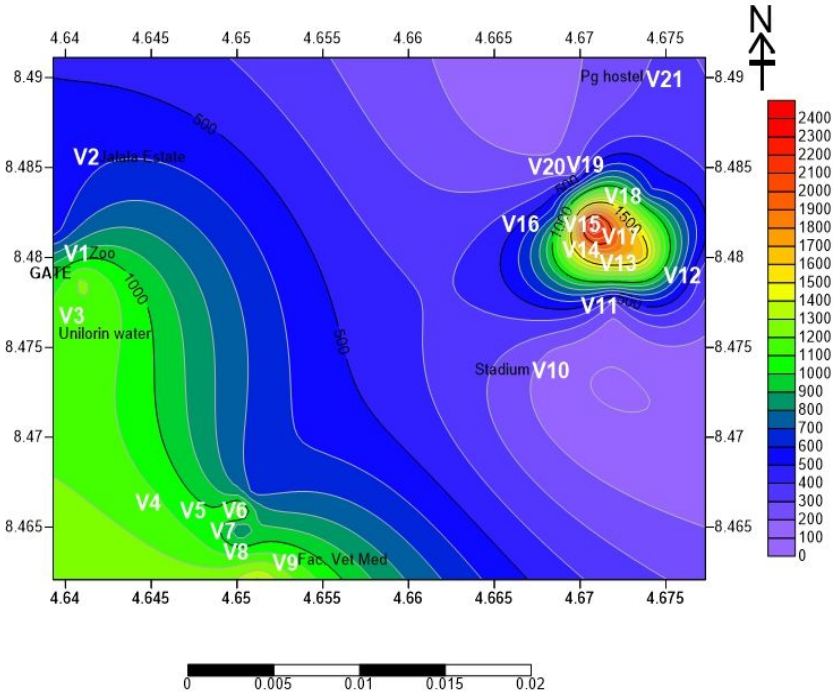

Fig. 8: Transmissivity Distribution

Conclusion

From the results, aquifers here are made of clay, weathered and fractured basement rocks. There exist three to four subsurface layers. The first layer, top-soil has apparent resistivity of 130 to 1469 Ωm. The second layer is clay with apparent resistivity of 52.6 to 8552 Ωm. The third layer is weathered or fractured basement having apparent resistivity of 46.2 to 249 Ωm while the fourth layer is fresh basement with apparent resistivity of 454 to 5022 Ωm. The aquifer thickness and depth range is 1.89 to 22.7 m and 6.17m to 26.5 m.

The NW, NE and part of SW (representing 62%) reflects good protective capacity rating as can be envisaged from the high longitudinal conductance range of 0.412 Ω^{-1}- 0.468 Ω^{-1}. 38% of the area withness low S value, with a minimum of 0.02 Ω^{-1} in the SE. The recharge ability, T, after pumping shows a range of 246 Ωm^2 to 2419.8 Ωm^2.

The most recommended location would be that which has high protective cover, thick and deep aquifer; and high transmissivity. VES 3 most satisfied this condition as the borehole there is

effective. VES 17, although has high S value, coincides with low T value (624.2 Ωm^2) which could be among the reasons for the failure of the borehole there (Table 1). VES 6 coincides with low protective cover (S = 0.08 Ω^{-1}). That could have been one of the reasons responsible for the contamination of the borehole in that location (Table 1). Among the reasons for the failure of other boreholes such as those located at VES's 5 and 8 could be due to the low transmissivity values around their vicinities (Fig. 8).

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2-DIMENTIONAL MODELS OF THE STRUCTURAL FEATURES WITHIN THE LOWER BENUE AND UPPER ANAMBRA BASINS NIGERIA, USING (2009) AEROMAGNETIC DATA

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Abstract
Analysis base on the CET shows that the basement rocks to the North and Southern edge of the study area intrude into the sedimentary formation. At the lower (middle-portion) of the study area (within Angba and Otukpo sheets) are structures that are Basaltic rocks that intrude into the basement. It is believed that these structures must have predated the depositional period of the sedimentary formation. Several fracture and fault lines are detected on the CET map, most prominent among is that which start from the Eastern end (latitude 7.45^0 and longitude 8.30^0) and ends at the Southern end (Latitude 7.00^0 longitude 7.45^0).cutting the South Western corner of the study area diagonally. Secondly is that which runs vertically and is parallel to the course of River Niger within this area, supporting the assertion that the River Niger is structurally controlled. The 2-dimentional models of the six profiles revealed sedimentary formations whose susceptibility values are zero (0). Maximum depth of about ten (10) kilometers was obtained within the Southern end of the study area, but a maximum thickness of sedimentation of about four (4) kilometers was observed on profile six within Nkporo formation. The basement susceptibility varies from 0.002 to 0.004 but in some places it is as high as 0.007.

Keywords: Structural, 2-dimensional, Exploration Targeting, Total Magnetic Intensity

Introduction
The Benue Trough is a linear rift system whose development was closely associated with the separation of Africa from South America and the opening of the South Atlantic Ocean. It is about 250 km wide in its southern portion, if we include the Anambra Basin, the Abakaliki Anticlinorium and the Afikpo Syncline (Benkhelil, 1989, Ladipo, 1988). Towards the northeast, the width of the trough varies between 80 and 150 km while its overall length is about 800 km. A succession of sediments increasing in thickness, from about 2.5 km in the northeast to over 7 km in the southwest was deposited in the trough in the Cretaceous (Reijers & Nwajide, 1998, 1997). These sediments consisting dominantly of mudrocks and sandstones with occurrences of carbonates and coal were in several places intruded by igneous rocks of felsic intermediate and mafic composition.

Geological studies have shown that the trough was subjected to several depositional cycles which resulted in the deposition of sedimentary rocks of varied compositions and ages (Benkhelil, 19895, Petters & Ekweozor, 1982, Reijers & Nwajide, 1997). Three of these depositional cycles were more pronounced than the rest. A lot of research has been carried out within the Benue and Anambra basins, the Benue Trough is generally known to contain numerous mafic and felsic intrusives, sub- basinal structures together with a bright prospect for hydrocarbon accumulation (Ugbor, 2007; Petters & Ekweozor, 1982). The aim of this present study is therefore, to carry out geophysical investigation in the study area with a view of

obtaining information on depth of sediments in the area through their effects on the magnetic field. The availability of a very high resolution aeromagnetic data and more modern processing software will enable the research to reveal as much as possible the geologic and geophysical features of the area which will in turn reveal the structural setting within the area.

Location of the Study Area

The study area covers the Lower Benue Trough, the Upper part of Anambra Basin and the basement complexes bounding it at the West and Northern edges. The area is bounded by Latitude 7.0^{0}N to 8.5^{0}N and Longitude 6.5^{0}E to 8.5^{0}E. The physiological features recognized in the area are the river Benue, river Anambra and river Okulu. Twelve aeromagnetic maps covered the study area and are numbered, 227, 228, 229, 230, 247, 248, 249, 250, 267, 268, 269 and 270. An area of 36,300 square kilometers that touches four states majorly, which are Nassarawa at the upper part, Kogi, Enugu and Benue States at the lower part (Figure 1 & 2).

Geology of Lower Benue and Upper Anambra Basin

Sedimentation in the Lower Benue Trough commenced with the marine Albian *Asu River Group*, although some pyroclastics of Aptian – Early Albian ages have been sparingly reported (Petters, 1977). The Asu River Group in the Lower Benue Trough comprises the shales, limestones and sandstone lenses of the Abakaliki Formation in the Abakaliki area and the Mfamosing Limestone in the Calabar Flank (Ojoh, 1992). The marine Cenomanian – Turonian *Nkalagu Formation* (black shales, limestones

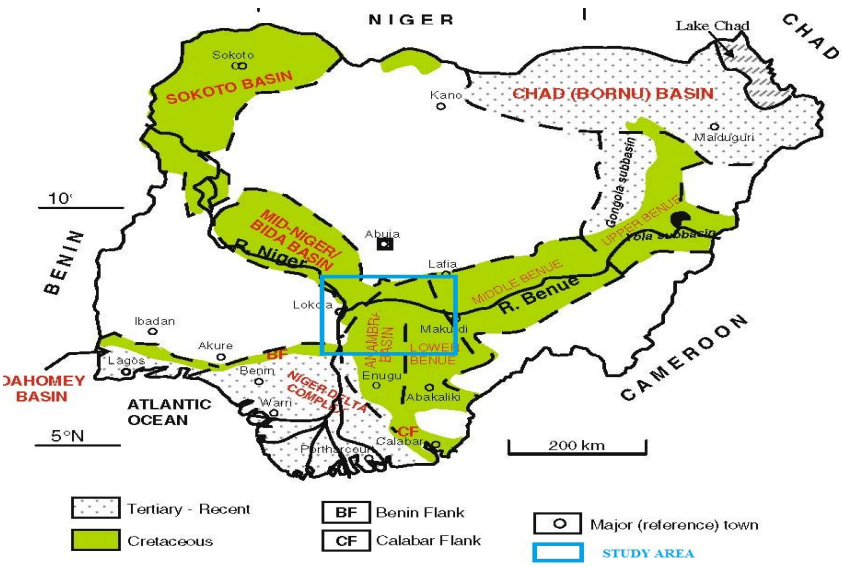
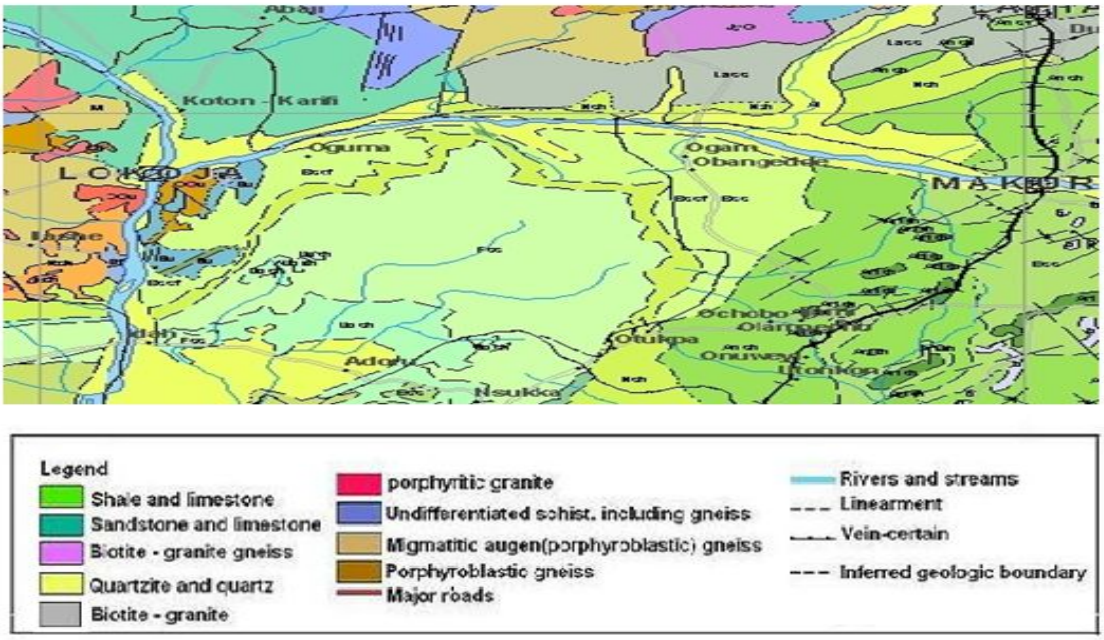


Figure 1: Cretaceous to Recent sediments representing the third phase of marine sedimentation in the Benue Trough (Akande & Erdtmann, 1998)



and siltsones) and the interfingering regressive sandstones of the *Agala* and Agbani Formations rest on the Asu River Group. Mid-Santonian deformation in the Benue Trough displaced the major depositional axis westward which led to the formation of the Anambra Basin. Post-deformational sedimentation that take place within south of the Lower Benue Trough generated the Anambra Basin. Sedimentation in the Anambra Basin thus commenced with the Campanian-Maastrichtian marine and paralic shales of the Enugu and Nkporo Formations overlain by the coal measures of the Mamu Formation. The fluviodeltaic sandstones of the Ajali and Owelli Formations lie on the Mamu Formation and constitute its lateral equivalents in most places. In the Paleocene, the marine shales of the Imo and Nsukka Formations were deposited, overlain by the tidal Nanka Sandstone of Eocene age. Down dip, towards the Niger Delta. Akata Formation of the Niger Delta Basin and Nsukka Formation of the Anambra Basin are Paleocene lithofacies equivalent. The Basin Formation and the Imo Shale mark the onset of another transgression in the Anambra during the aleocene. The shales contain significant amount of organic matter and may be potential source for the hydrocarbons in the northern part of the Niger Delta (Reijers & Nwajide, 1998). In the Anambra Basin, they are only locally expected to reach maturity levels for hydrocarbon expulsion.

The Enugu and the Nkporo Shales represent the brackish marsh and fossiliferous pro-delta facies of the Late Campanian-Early Maastrichtian depositional cycle (Ugbor, 2007). Deposition of the sediments of the Nkporo/Enugu Formations reflects a funnel-shaped shallow marine setting Figure: 2 Geology Map of the Study area, from Nigerian Geological Survey Agency, 2009. that graded into channeled low-energy marshes. The coal-bearing Mamu Formation and the Ajali Sandstone accumulated during this epoch of overall regression of the Nkporo cycle. The Mamu Formation occurs as a narrow strip trending north–south from the Calabar Flank, swinging west around the Ankpa plateau and terminating at Idah near the River Niger The best exposure of the Nkporo Shale is at the village of Leru (Lopauku).

The Ajali Sandstone marks the height of the regression at a time when the coastline was still concave. The converging littoral drift cells governed the sedimentation and are reflected in the

tidal sand waves which are characteristic for the 72 km south of Enugu on the Enugu – Portharcourt express road, while that of Enugu Shale is at Enugu, near the Onitsha-Road flyover The Mamu Formation is best exposed at the Miliken Hills in Enugu, with well-preserved secions along the road to Onyeama mine at the left bank of River Ekulu (Offodile, 1980).

Methods

The procedures employed in this research include:

(i) Production and interpretation of Total Magnetic Intensity (TMI) map of the study area using Oasis Montaj software.
(ii) Application of Centre for Exploration Targeting (CET) Grid Analysis Plug-In For Structural analysis
(iii) Modeling the identified structures within the study area

Source of Aeromagnetic Data

The by Fugro Airborne Surveys, between 2003 and 2010 carried out the largest airborne geophysical survey ever undertaken in Nigeria. This data acquisition and compilation covers the entire Nigerian land mass, and have produced new data which is helping to position the country as an exciting destination for explorers. The recent data has a Tie-line spacing of 500 m, flight line spacing of 100m and flying altitude of 100 m. For the purpose of this research data covering the study area will be acquire from "The Nigerian Geological Survey Agency who is mandated to archive all geological and geophysical datasets for the entire country.

Objectives

The Centre for Exploration Targeting (CET) Grid Analysis Plug-In For Structures CET is four stages of analysis, comprising of Standard deviation, Phase Symmetry, Amplitude Thresholding, and Skeleton to Vectors, (Won and Bevis 1987) which is aimed at structural analysis that results in:

(i) locating the contact between the basement and the sedimentary formation of the study area
(ii) locating the extent and position of the outcrops and intrusive bodieswithin the area
(iii) detecting fracture or any fault that may exist within the area
(iv) determining the thickness of the sedimentary rocks and the susceptibility of lithologies within the study area from 2-dmentional modeling of the Total Magnetic Intensity field.

Theory

Probably the most significant of the computer modeling algorithms are:

(i) Computation of the magnetic field of a two-dimensional (infinite strike) body with an arbitrary polygonal shape (15). This method calculates the effect of the polygon by summing the magnetic effect of a series of horizontal sheets with sloping edges that correspond to the sides of the polygon. Modeling with the routine is commonly referred to as 2D modeling. (Won and Bevis, 1987), have produced a faster version of this routine that can handle situations where the magnetic body can partly above the point of observation and where the observation point can be inside the magnetic body (Cady, 1980).

These routine have been incorporated into various proprietary and commercially available packages of which the most advanced work interactively in windows-type environments. These packages allow the interpreter such option as definition of regionals, computation of residuals multi-source model and inclusion of remanence, demagnetization and anisotrophy. The algorithms used for each modeling exercise depend upon whether the anomalies being

interpreted are sufficiently elongated for a two-dimensional or quasi two-dimensional approximation to be used or whether a three-dimensional model is required. The type of three-dimensional algorithm used depends on the form of the magnetic source and the detail required. Such routines have become basic interpretation tools; however, they can be time consuming to apply. They are suited to detailed analyses of single anomalies and cluster of anomalies and cannot be realistically applied to area depth determination problem.

For the data in this research, flight line ran north-south, and the interpretation of the data was done by drawing six profiles perpendicularly across the major structures identify within the study area, these six profiles were modeled using 2D modeling software a module in oasis montaj version 7.3

Results

The Total Magnetic Intensity (Tmi) Map of the Study Area

The total magnetic intensity map of the study area bounded by 7.0^0- 8.5^0N latitude and 6.50^0 - 8.0^0E longitude is produced into maps, (Figure: 4), which is in both color aggregate. The magnetic intensity of the area ranges from -2415.97 minimum to 1264.72 maximum with an average value of 33.87 nT. The total number of data points is 3,667,251. The area is marked by both high and low magnetic signatures, which could be attributed to several factors such as (1) variation in depth (2) difference in magnetic susceptibility (3) difference in lithology (4) degree of strike. The northern edge and the western edge of the study area are inhibited by short wavelength,(high frequency in occurrence) magnetic signatures, which are generally attributed to basement areas. These are mostly prominent on sheets (228) Katakwa, (229) Udegi and (247) Lokoja (Figure 3).

The Northern edge comprising of Koton Karfi, Katakwa , Udegi area and part of the Western edge of Lokoja sheet shows a lot of activities, as they are dotted by mixtures of both high and low magnetic signatures which are features that are characteristics of surface to near surface structures such outcrops. Undifferentiated granite mainly porphyritic granite granitized gneiss with porphyroblastic granite covers Obajana, Ajaokuta, Itobe in Kogi State. Biotite granite covers Gadabuke, Katakwa, Nyegba in Nasarawa State. Ayingba, Dekina, Ejule, Angba in Kogi State are covered by False bedded sandstone (Ajali Formation). Coal, sandstone and shale formation identified around Otukpa, Abejukolo and Ofugo in Kogi State; Abaji in FCT; Udegi and Amaku in Nasarawa State and areas in Benue and Enugu States.False bedded sandstone, coal, sandstone and shale are the lithologic units at the surface within the sedimentary basin. River Alluvium deposition identified along the river channel. These features are strategically targeted as shown in the six profile modeled (Figure 4).

Application of CET Grid Analysis Plug-In and Results

Application of the standard deviation and the phase symmetry plug-in, application of the amplitude thresholding and the skeleton to vectors plug-in from the CET extension of Oasis Montaj yielded the map in Figures 5 and 6. It will be observed that most of the lineaments are located within the basements bounding the basin to the Northern and Western edges. Some few Structures (Outcrop and Intrusive bodies) are located around the southern edges, and southeastern corner of the map. These structures are outcrop of magnetic basement rocks that intrude into the sedimentary Dormation; it is equally believe that these structures must have predate the depositional period , though no indication of their existence on the Geology and structural map of the area. On the vectorised structural map in (Figure. 6), it can be observed

that the southeastern corner of the study is located a NE-SW trending fracture line. From (Figure 5) we observe that the basement rocks at the North and Western edge and the sedimentary basin intrude into the sedimentary formation. Two major fault lines are observed, the first one running parallel to the course of River Niger within the area. The second one is that which cuts the South Western corner of the study area diagonally.

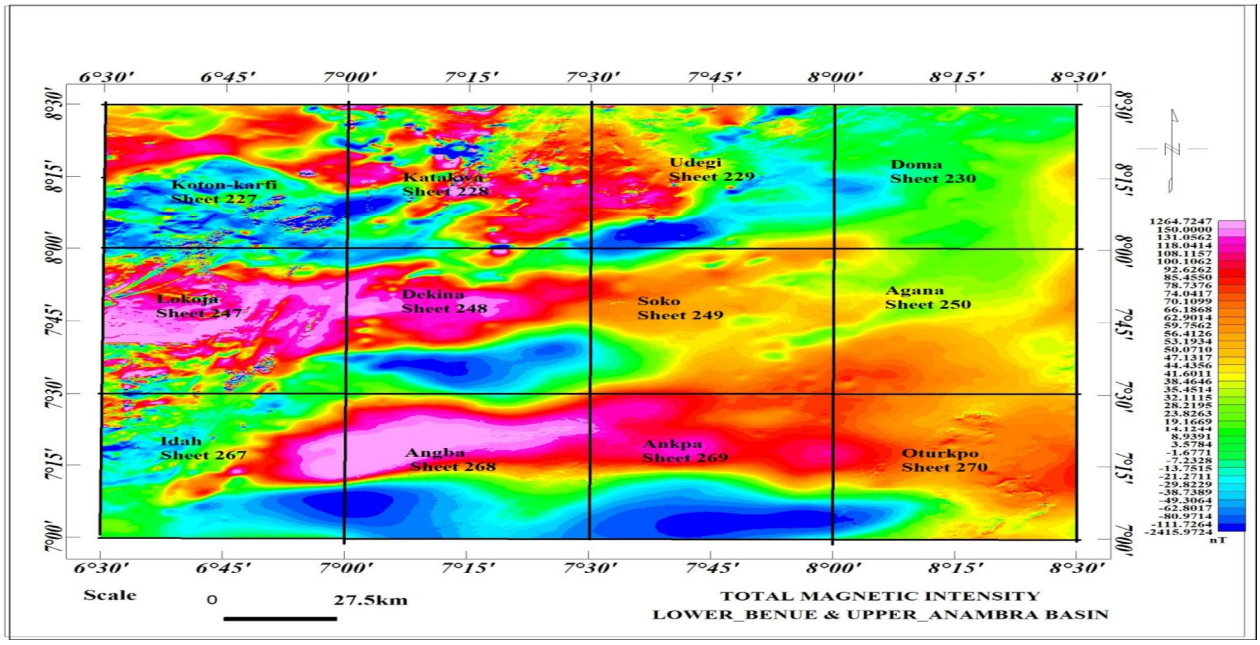


Figure 3: Total Magnetic Intensity Map of the Study Area showing major towns flown over

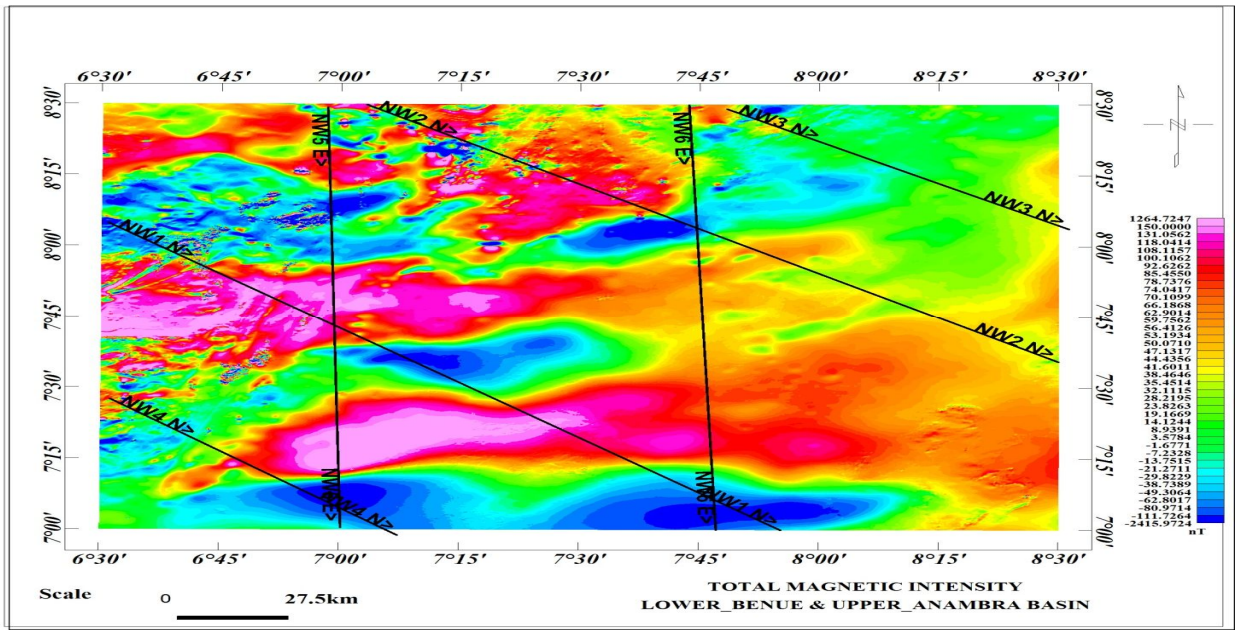


Figure 4: Total Magnetic Intensity Map showing Profiles Modeled

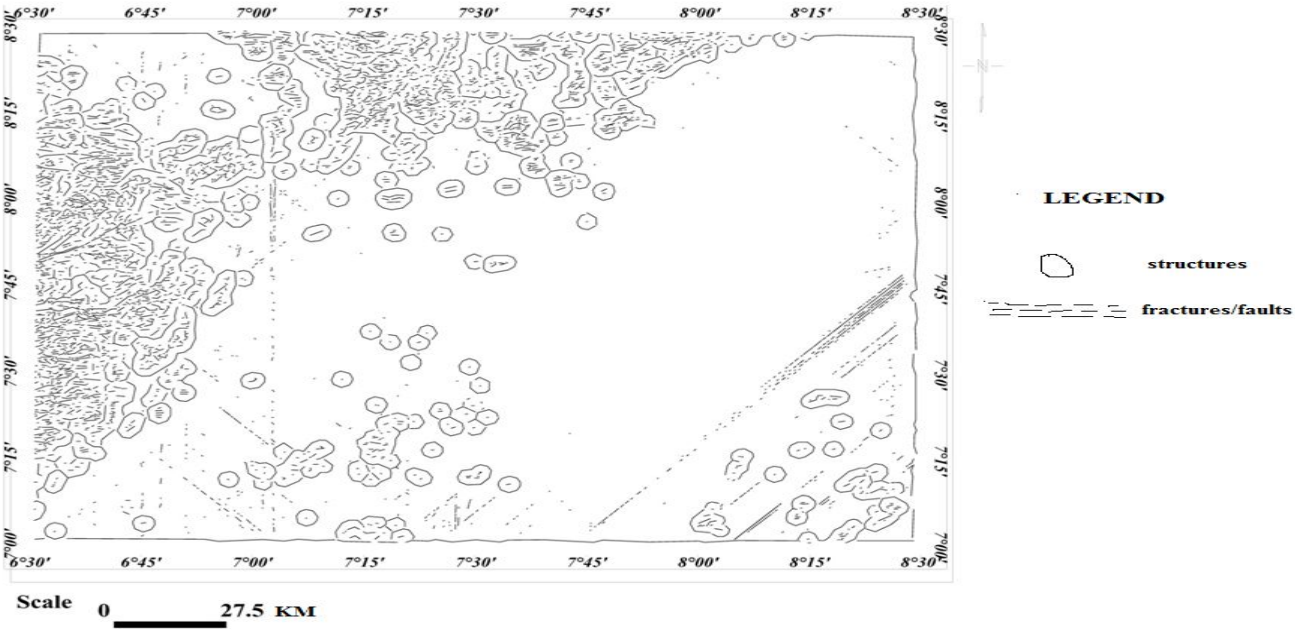


Figure 5: Vectorized Structural Map of the Study Area from CET_Plug-in

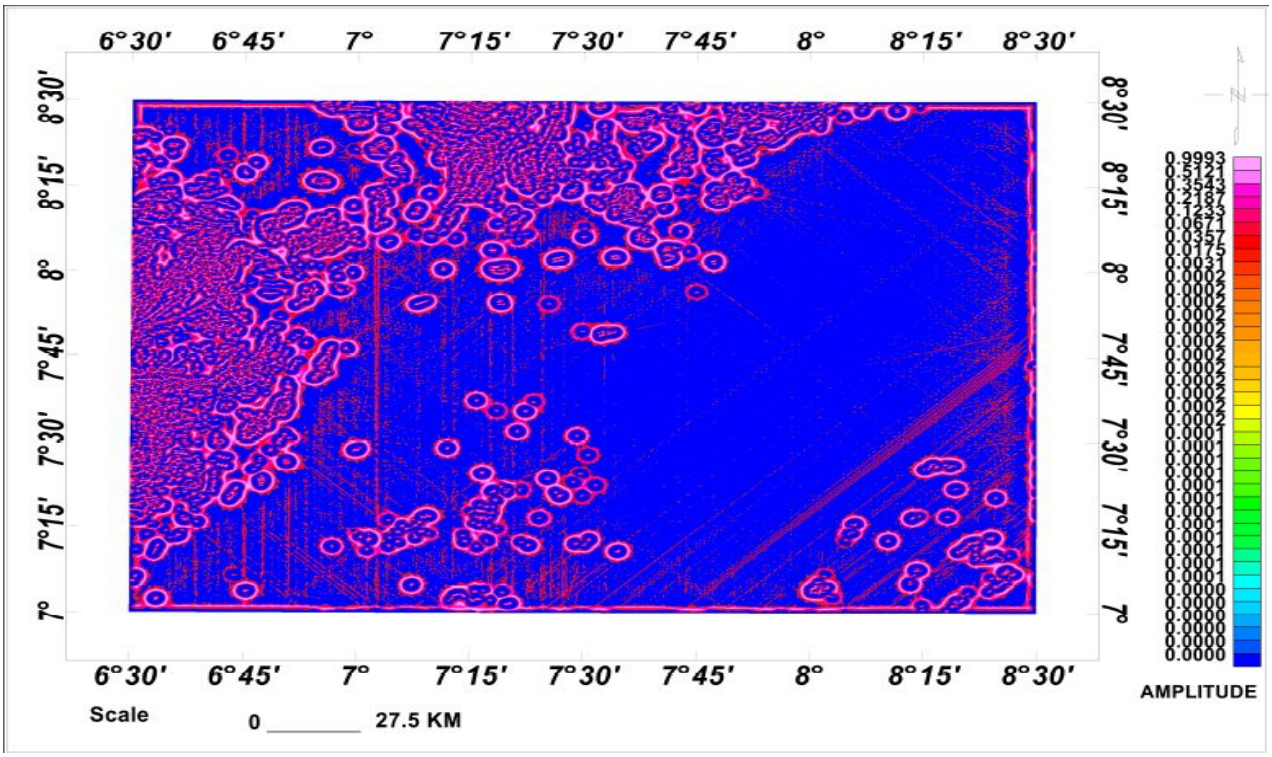


Figure 6: C E T-Vectorized Structural Map of the Study Area

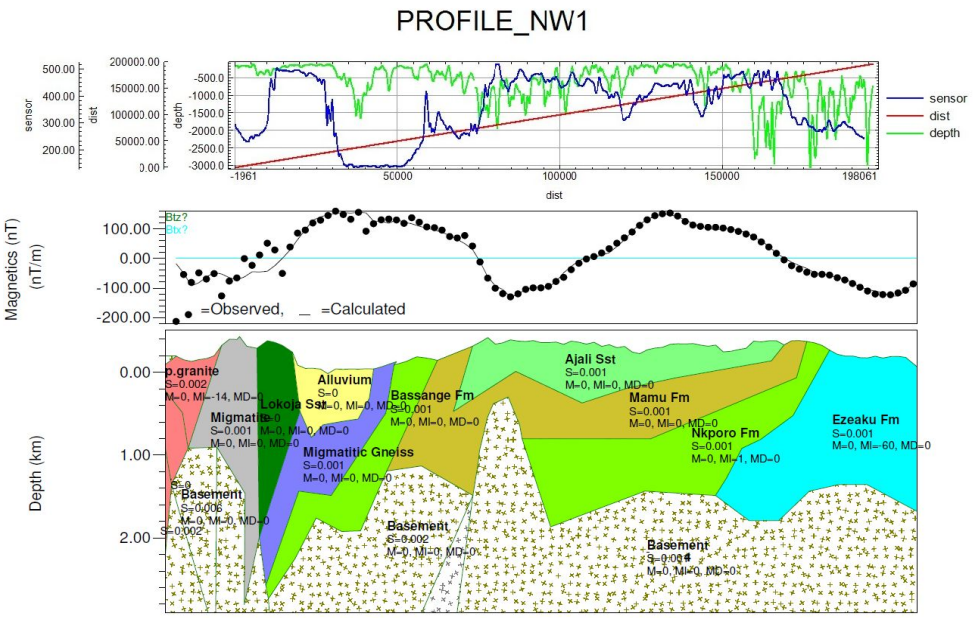
Modeling and Results

To accomplish a well documented modeling there is a need for a separate database. This database which is obtained from sampled grids consisting of the following:

A. The coordinates in Universal Transverse Mercator (UTM) geographic coordinate system or longitude and latitude value along the require profile
B. The TMI value along the grid profile
C. The SRTM (Shuttle Radar Topographic Mission Grid)
D. Depth – Which is sampled from the SPI value grid
E. The sensor – which is the SRTM+100 meters, 100 meter is the terrain clearance for this survey
F. The distances channel, which represents the length of each profile

Note that the sensor will determine the upper Z value while the dept+SPI value determent the depth along the profile.

For the purpose of this research six (6) profiles were selected to cut orthogonally through the major structures identified on the vertical derivative map of the study area. (Figure 4). They are labeled NW1, NW2, NW3, NW4, NW5 and NW6. Six different models are generated using 2-D modeling module form the oasis montage package. Moving around between the shapes, size of the body, its magnetic susceptibility, remannace magnetization, magnetic inclination and declination , an acceptable model is obtain, which poses good geological interpretation and an acceptable error margin. The result from the model produced are summarized in tables 1 to 6, these tables gives the name of rock(s) of sediment (relative to the region of occurrence), the average thickness of the sediment, its susceptibility, and the constituent of the rocks.



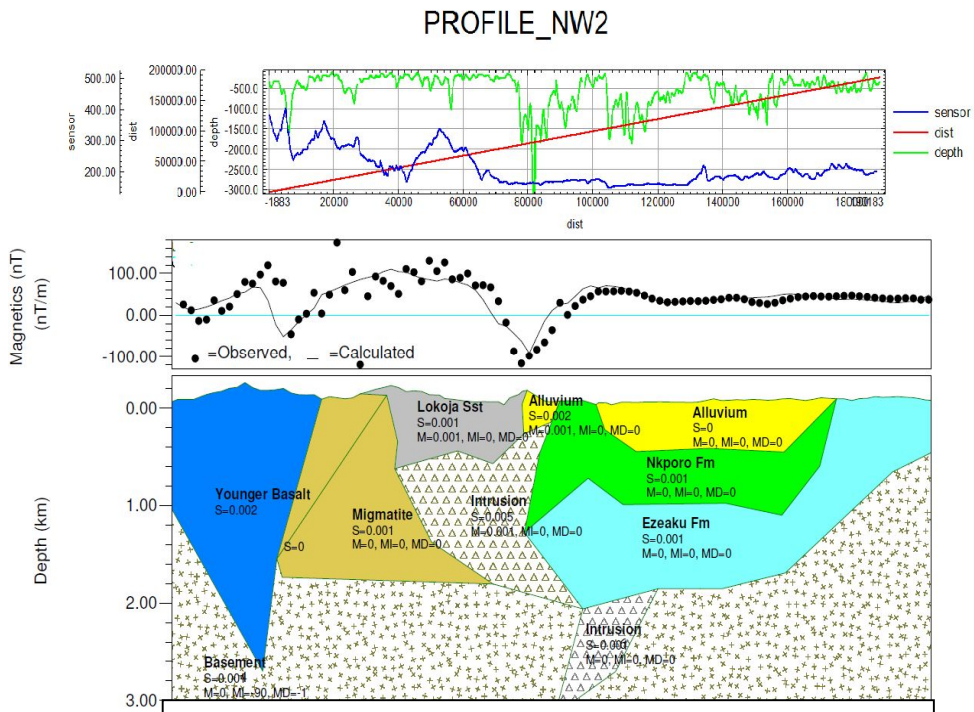


Figure 8: Profile and Model Map for Profile NW2

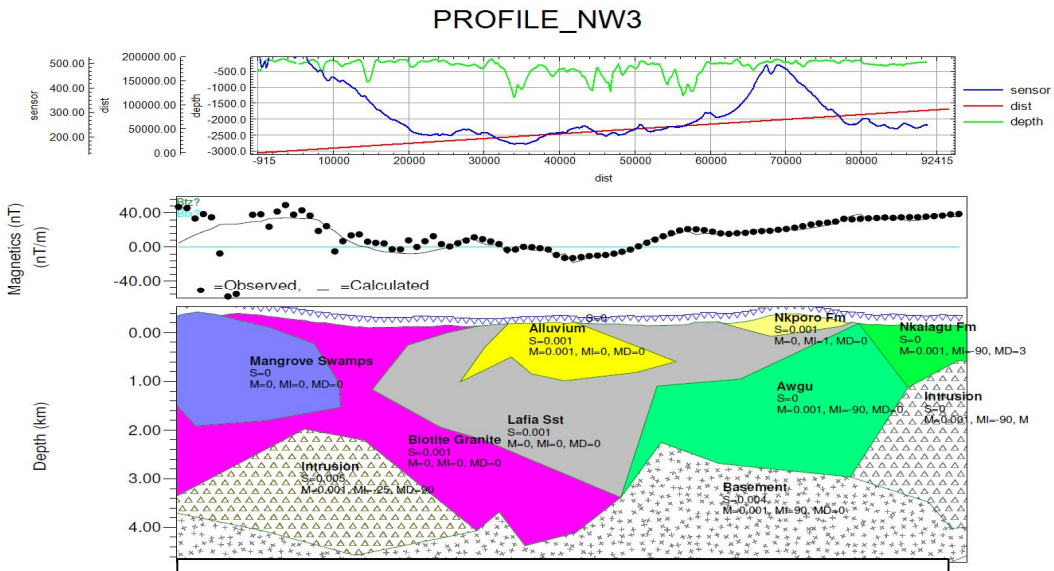


Figure 9: Profile and Model Map for Profile NW3

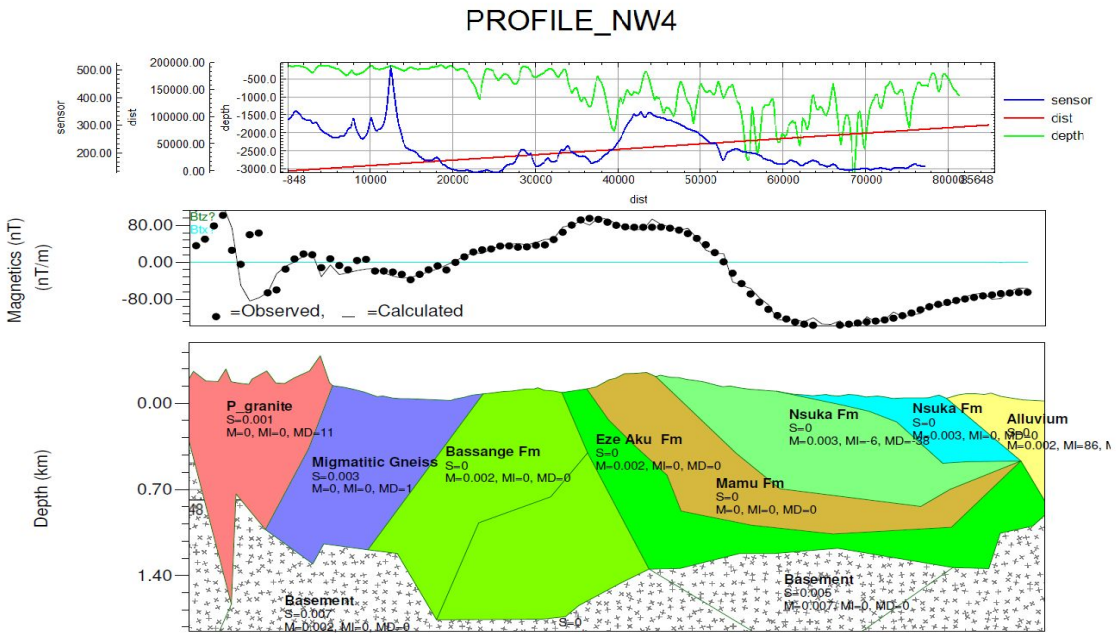


Figure 10: Profile and Model Map for Profile NW4

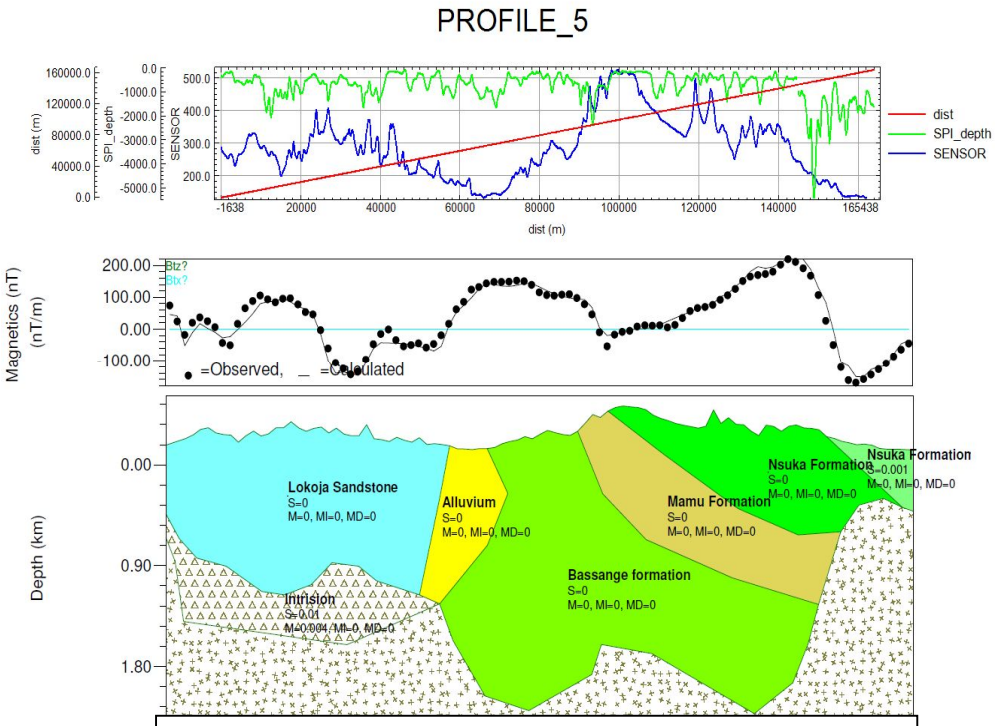


Figure 11: Profile and Model Map for Profile NW5

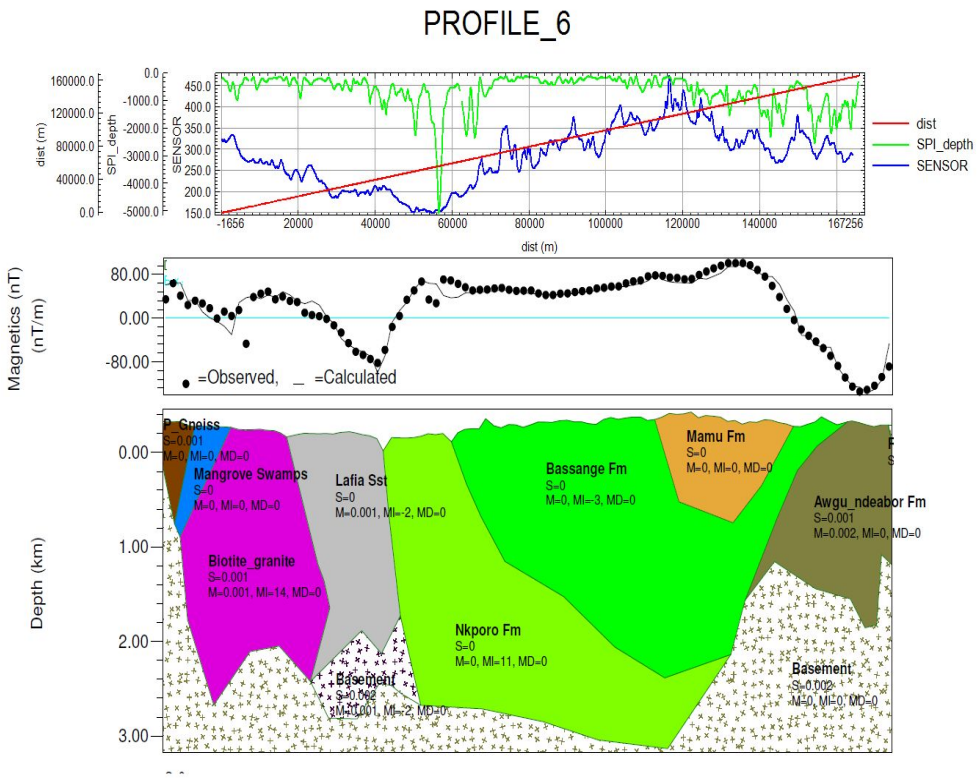


Figure 12: Profile and Model Map for Profile NW6

Table 1: Interpretation of Profile_1

S/N	Formation	Depth/Thickness	Susceptibility	Lithology
1	p-granite	1.2 km	0.2	Grantic rocks
2	Migmatile	2.5 km	0.001	Migmatic rocks
3	Lokoja sand stone	2 km	0	Sand stone and Siltstone
4	River alluvium	400 m	0	Sand and river alluvium
5	Migmatite gnesis	2.5 km	0.001	Migmatic rocks
6	Bassange Formation	400 m	0.001	Sand stone Ironstone
7	Mamu Formation	400 m	0.0001	Sand stone Sandy-shale and coal
8	Nkporo Formation	500 m	0.001	Shale Mudstone and sandstone
9	Eze-Aku Formation	1.5 km	0.001	Sandstone Black shale and Siltstone
10	Basement	-	0.002–0.004	Basement Rocks

Table: 2: Interpretation of Profile_2

S/N	Formation	Depth/Thicknes	Susceptibility	Lithology
1	Young Basalt	2.8 km	0.002	Basaltic rocks
2	Migmatite	1.5 km	0.001	Migmatic rocks
3	Lokoja sand stone	400 m	0.001	Sand stone and Siltstone
4	River Alluvium	300 m	0	River alluvium
5	Nkporo Formation	400 m	0.001	Shale Mudstone and sandstone
6	River Alluvium	300 m	0	River alluvium
7	Eze-Aku Formation	500 m	0.001	Sandstone Black shale and Siltstone
8	Basement	-	0.002 – 0.004	Basement Rocks

Table: 3: Interpretation of Profile_3

S/N	Formation	Depth/Thickness	Susceptibility	Lithology
1	Mangrove swamps	500 m	0.001	Sand, Clay, Siltstone and Limestone
2	Biotite-granite	2.1 km	0.001	Granitic rocks
3	Lafia sandstone	600 m	0.001	Sand stone iron stone
4	River Alluvium	400 m	0.001	River alluvium
5	Nkporo Formation	100 m	0.001	Sand stone shale
6	Awgu Fm	2 km	0	Shale sand stone coal
7	Nkalagu Formation	900 m	0	Shale sand stone coal
8	Basement	-	0.002 – 0.004	Basement Rocks

Table: 4: Interpretation of Profile_4

S/N	Formation	Depth/Thickness	Susceptibility	Lithology
1	p-granite	1.6 km	0.001	Granitic rocks
2	Magmatic gnesis	1 km	0.003	Migmatic rocks
3	Bassange Formation	1.6 km	0	Coal sand stone shale
4	Ezeaku Formation	400 m	0	Coal sand stone shale
5	Mamu Formation	400 m	0	Coal sand stone shale
6	Nsuka Formation	400 m	0	Coal sand stone shale
7	Nsuka Formation	300 m	0	Coal sand stone shale
8	River Alluvium	300 m	0	River alluvium
9	Basement	-	0.002 – 0.004	Basement Rocks

Table 5: Interpretation of Profile_5

S/N	Formation	Depth/Thickness	Susceptibility	Lithology
1	Lokoja sand stone	1200 meters	0	Sand stone and iron stone
2	River Alluvium	1100 meters	0	River alluvium
3	Bassange Formation	2200 meters	0	Coal sand stone shale
4	Mamu Formation	200 meters	0	Coal sand stone shale
5	Nsuka Formation	500 meters	0	Coal sand stone shale
6	Basement	-	0.002 – 0.004	Basement Rocks

Table 6: Interpretation of Profile_6

S/N	Formation	Depth/Thickness	Susceptibility	Lithology
1	Migmatite Gneiss	500 m	0.001	Sand stone alluvium
2	Mangrove swamps	500 m	0	Granitic rocks
3	Biotite granite	2.4 km	0.001	Sand stone iron stone
4	Lafia sandstone	2.4 km	0	Sand stone shale iron stone
5	Nkporo Formation	2.5 km	0	Sand stone shale coal
6	Bassange Formation	2 km	0	Shale sand stone ironstone
7	Mamu Formation	600 m	0	Shale sand stone coal
8	Awgu-Ndeabor Fm	1.2 km	0.001	Sand stone shale coal
9	Basement	-	0.002 – 0.004	Basement Rocks

Conclusions

The following conclusions were drawn:

(i) The major structural trend observed within the study area, which are NE – SW (at the upper part of the area) and E – W (at the lower part of the area) (Figures: 3 and 4), coupled with the direction of fault line identified in the study area on (Figure: 4.) and that observed from the CET grid analysis in Figure :4 that strike NE – SW, indicates, a rifting and spreading of continental plates, a process that results in spreading tractions in the earth's crust and create some lineaments and faults along which long and narrow depressions bounded by steep slopes occurred (Talwani, and Heirtzler 1960, Beaumont, 1978). Structures mapped on at the Northern and Western part of the study area, which coincide with the basement region are possible mineral veins located within the study area. Maximum depth of about ten (10) kilometers was obtained within the Southern end of the study area, but a maximum thickness of sedimentation of about four (4) kilometers was observed on profile six within Nkporo formation (Adetona & Abu, 2013) this is a favorable depth for geothermal gradient in hydrocarbon generation.

(ii) A major vertically fault line that structurally define the course of river Niger within the study area, and the extension of Chain's fault line that cuts the South East corner of the study area (Figure 5) coupled with the the presence of a basement uplift (Abakaliki uplift) adjacent to the study area cerate's an Isostatic adjustment of the graben-sag along week fault zones as blocks sink down in response to the traction, giving a depression which sediments can accumulate (Beaumont, 1978)

(iii) Considering the existence of intrusive structures of Basaltic rocks within the lower portion of the study area around Udegi and Angba, as revealed by Analytical Signal and CET grid analysis, (Figure 6) supports the theory of intrusion of dense material such as

basaltic intrusion into crustal rocks, this emplacement will act as a weight. During isostatic adjustment a depression is created on the surface directly above the dense material where sediments can accumulate (Beaumont, 1978)

(iv) Deduction from the models produced from 2D modeling package, shows that the susceptibility of the sediments is generally zero, except in isolated cases such as in profile one where the profile passes through the highly susceptible basaltic body which slightly influence the susceptibility of the sediments. Susceptibility of basement rocks varies from 0.03 to about 0.07. Despite the classification of the study area into Lower Benue and Upper Anambra basins similar lithologies such as mamu, Nkporo and Bassange formations transcend the two basins thus Anambra basin can be said to be an extension of the larger Banue Basin. Deduction from models produced from 2D models shows that: susceptibility of the sediments is generally zero, except in isolated cases Susceptibility of basement rocks varies from 0.03 to 0.07. Thickness of sedimentation obtained within the area are:
profile 1 = 2.1 km_ Nkporo formatiom
Prifile 2 = 3.2 km_ Lafia formation
Prifile 3 = 2.0 km _Ezeaku formation
Prifile 4 = 2.1 km _Bassange formation
Prifile 5 = 1.2 km _Bassange formation
Prifile 6 = 4.2 km _ Nkporo formation

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AN INTERCALATED DUAL GEOELECTRICAL SURVEY OF AN EARLIER STUDY FOR GROUNDWATER AT THE PLANNED GIDAN KWANO CAMPUS DEVELOPMENT PHASE II, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA

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Abstract

The earlier study at the planned Gidan Kwano Campus was a sole vertical electrical sounding (VES) survey concerned with identifying aquifer prospects, as well as providing geotechnical information for a 2km^2 areal extent subsumed in the greater Phase II Development. The aim of the present study is to plug the knowledge gaps of geological information for the intervening 200m-spread station spacing of the earlier survey; the objectives herein are to validate the conclusions drawn with respect to aquifer prospects from the earlier survey using the earlier method and an IP discriminator and define a framework by which studies of this format (i.e. georeferenced) could easily be replicated. Because of the dual vertical electrical sounding-induced polarisation (IP) nature of this survey, the areal extent of this project work was limited to 1km^2 and survey proceeded in the transverse traverse (i.e. TT) sense for individual stations and a south-north profile. Initially, each of the thirty-six intercalated survey stations, six on a TT, were georeferenced in terms of their x, y, z variables (i.e. latitude, longitude, elevation) using the hand-held Garmin72 Global Positioning System (GPS) unit. The Schlumberger array of the VES mode was employed for both the resistivity and the induced polarisation surveys. The results obtained indicated that the following VES locations are considered good prospects for groundwater: TT1-2, TT1-3, TT1-4, TT1-6, TT2-1, TT2-2, TT2-3, TT2-4, TT3-1, TT3-2, TT3-3, TT3-4, TT3-5, TT4-1, TT4-2, TT4-3, TT4-4, TT4-5, TT5-1 TT5-2, TT5-4, TT5-5, TT6-5, and TT6-6. The IP data set was used in a qualitative sense for this survey to constrain the conclusion drawn regarding the most promising VES locations of TT5-4, TT1-2, TT1-3, and TT2-2.

Keywords: Intercalation; Resistivity; Chargeability; Groundwater; Aquifer

Introduction

The earlier study at the planned Gidan Kwano Campus was a vertical electrical sounding (VES) survey concerned with identifying aquifer prospects, as well as providing geotechnical information for a 2km^2 areal extent of survey subsumed in the greater Phase II Development (Jonah *et al.*, 2014I). It was pointed out also that the extent of this greater Phase II Development was an 8km^2 area forming a contiguous landmass with the existing Phase I. The initial plan for this project was to occupy coincident points of the earlier study and do sole induced polarization (IP) survey to serve as a validation tool of the earlier survey, especially with the conclusions drawn regarding aquifer prospects. Survey-station identification for the earlier study was aided by the hand-held Garmin GPSmap76 unit, while the hand-held Garmin72 was the unit available for this present study. Alas, it was observed in the field that the ground locations of the same latitude and longitude numerical specifications were not coincident for the Garmin GPSmap76 and the Garmin72 units. Actually, the ground location of Garmin GPSmap76

was exactly 100m to the east of that of Garmin 72 along a constant line of latitude. Thus, since a strictly validation exercise could not be carried out because of unavailability of Garmin GPSmap76, it was decided to do a dual VES-IP along constant lines of latitude for survey stations that are necessarily intercalated with those of the earlier study. No doubt, the final result of this study would enhance the aquifer prospect database generated by the earlier study. Nowadays, because of the need to ensure independent verification of the results being presented, it is instructive to adopt the practice of georeferencing survey and prospect stations. This practice, in effect, also eliminates the awkward requirement of using wooden pegs to identify survey and prospect locations. In fact, Jonah and Duromola (2014A), Jonah and Ayofe (2014B), Jonah and Bawa (2014C), Jonah *et al.* (2014D; 2014E; 2014F; 2014G; 2014H; 2014I; 2014J), Jonah and Jimoh (2013A), Jonah *et al.* (2013B; 2013C; 2013D), and Jonah *et al.* (2011A; 2011B; 2011C; 2011D) have always argued in favour of georeferencing field data and their concomitant tie-in to their specific GIS database.

Whilst the earlier survey was a sole VES exercise at 200m station-spacing over the 2km^2 areal extent, this present intercalated survey was limited to 1km^2 because of the its dual VES-IP nature. What is understood here is that the ground location of a specific station designation of the present survey is exactly 100m to the west of that same specific station designation of that of the earlier survey. In this case, TT1-1 of the present survey is intercalated between TT1-1 and TT1-2 of the earlier survey: TT1-1 of the present survey is exactly mid-point of TT1-1 and TT1-2 of the earlier survey; TT1-1 of the present survey is 100m west of TT1-1 of the earlier survey and 100m east of TT1-2 of the earlier survey.

The Area of Study

The 1km^2 areal extent of this survey is subsumed in the greater Phase II Development. Its georeferenced co-ordinates are the following: 09^{0}30′57.8′′N, 006^{0}25′39.0′′E; 09^{0}30′57.8′′N, 006^{0}26′11.4′′E; 09^{0}31′30.2′′N, 006^{0}26′11.4′′E; 09^{0}31′30.2′′N, 006^{0}25′39.0′′E.

The Phase II Development at the Gidan Kwano Campus: The location most suited for the Phase II Development at the Gidan Kwano Campus is the 8km^2 areal extent shown in Fig.1, defined to be a perfect rectangle on the ground with its ends corresponding to the following georeferenced co-ordinates: 09^{0}30′57.8′′N, 006^{0}25′39.0′′E; 09^{0}30′57.8′′N, 006^{0}26′43.8′′E; 09^{0}33′07.4′′N, 006^{0}26′43.8′′E; 09^{0}33′07.4′′N, 006^{0}25′39.0′′E (Jonah *et al.*, 2014I).

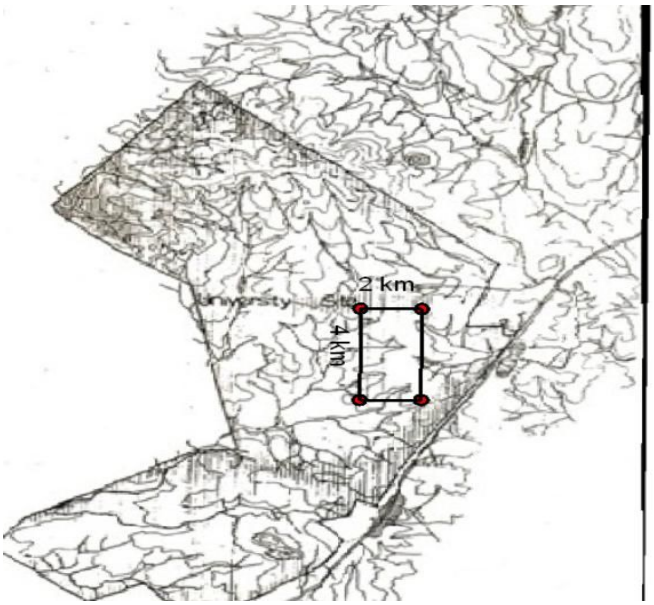

Fig.1. Location most suited for Phase II development at the Gidan Kwano Campus

Literature Review

With respect to studies that have been done at the Gidan Kwano Campus Phase II Development, Jonah *et al*. (2014I; 2014J) may be readily cited. Jonah *et al*. (2014I) reported that the desire of the management of the Federal University of Technology (F.U.T.), Minna, to inaugurate the structural development of Phase II of the Gidan Kwano Campus presented a challenge for the F.U.T. as to the creation of a database that the F.U.T. could consult and incorporate into the wider Physical Planning and Development (PPD) scheme. The authors pointed out that the objective of this study was the creation of a database for aquifer and geotechnical information. Station-separation for this 2km^2 areal extent of the study area was fixed at 200m; thus there were sixty-six principal stations slated for this survey. Further, the authors remarked that, because of the need to ensure independent verification of the results being presented, georeferencing of all survey stations for the vertical electrical sounding (VES) investigation was carried out too. However, only sixty-four principal stations were occupied for this exercise because locations of transverse traverse 11-2 and 11-4 (TT11-2 and TT11-4) were coincident with the top of large outcrops. The authors reported that the data collected was processed by means of the windows-compatible WinResist tool to determine the number of layers at each VES station and the Surfer 10 tool to produce the iso-resistivity maps at depths and the map of the thickness regime that is always desired for geotechnical interpretation. The authors clarified that, as a result of invoking the "Geoexplore Empirical Standardization for Minna Area," the "Olasehinde Protocol," and using the depth map as a strict control the VES locations identified as TT1-3, TT1-4, TT2-4, TT4-1, and TT4-3 were flagged as "strongly aquiferous." It was understood that the region of all TT9s, TT10s, and TT11s, incidentally closest to the existing Phase I development, especially TT9-3, TT9-4, TT10-3 were most suited for locations that would not prove logistical challenges for site selection for buildings and other structural development. The authors recommended that the result of this study be adopted wholeheartedly by the Management of the Federal University of Technology, Minna, as a complementary document for the development of Phase II of the Gidan Kwano Campus.

Jonah *et al*. (2014J) concerns the evaluation of geomorphological quality control of geoelectrical data at the Gidan Kwano Campus Development Phase II. The authors pointed out that as part of a

suite of protocols needed as controls for geoelectrical data collected out in the field, a purpose-specific topographic map was created to serve as a veritable tool of quality control (QC) for an ongoing fieldwork. It is understood that the three spatial co-ordinate values (x,y,z) that specified full-body georeferencing scheme were collected for 861 principal stations for an 8km^2 grid corresponding to station-spacing of 100m. The authors reported that processing the data set by means of the Surfer®10 route yielded the desired contour map and the corresponding landform profile. As a fine-tuning technique, the authors juxtaposed the landform profile map with acquired geoelectrical field data and they observed correlation that ensures that the field data can indeed be relied upon.

Dataset of Study

Only once was a wet stream barrier that precluded data collection encountered at TT5-3. Otherwise, there were 35 separate VES and IP readings to a depth of 200m except where the natural barriers of stream, thicket, or outcrop were impediments.

Results and Discussion

Initially, the VES field resistance values in ohms were converted to corresponding resistivity values by multiplying each of the resistance values by its corresponding geometrical factor. The IP values, in chargeability of milliseconds, need no such processing involving the geometrical factors.

Interpretation of Present Intercalated Vertical Electrical Sounding (VES) Data: The field resistivity values were initially subjected to the log-log plot routine of the Windows-compatible WinResist® software whence corresponding field curves for all the stations occupied were produced. Each of the WinResist® log-log plot provides information on the numbers of layers, the average resistivity values of these layers, and their approximate thicknesses.

Production of Iso-Resistivity Maps at Depths: In order to show the variation of resistivity on a constant plane across the area of study, it is necessary to produce resistivity maps at constant depths (i.e. the iso-resistivity maps). For this study, the Surfer® 10 software was used to generate the iso-resistivity maps at 10m, 20m, 30m, 40m, 50m, 60m, 70m, 80m, 90m, and 100m, see Figs 2 to 11.

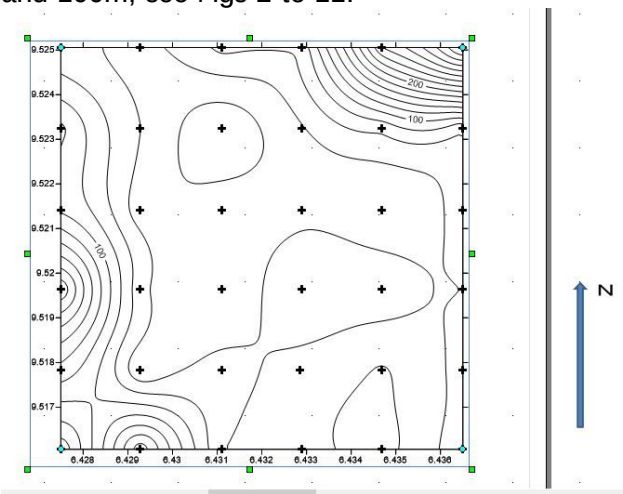

Fig.2: Iso-resistivity map **at 10m (Contour interval: 20Ωm**)

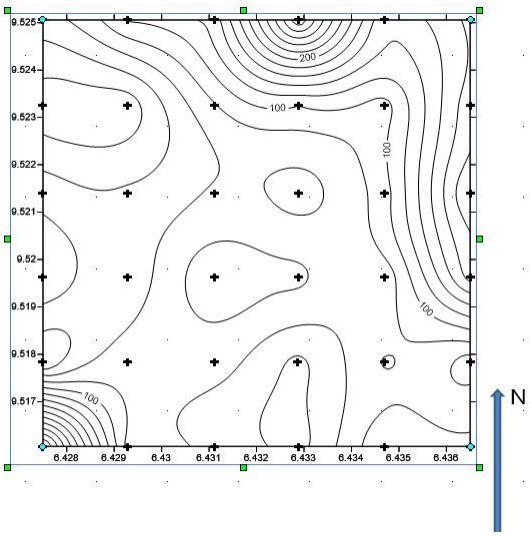

Fig.3: Iso-resistivity map **at 20m (Contour interval: 20Ωm**)

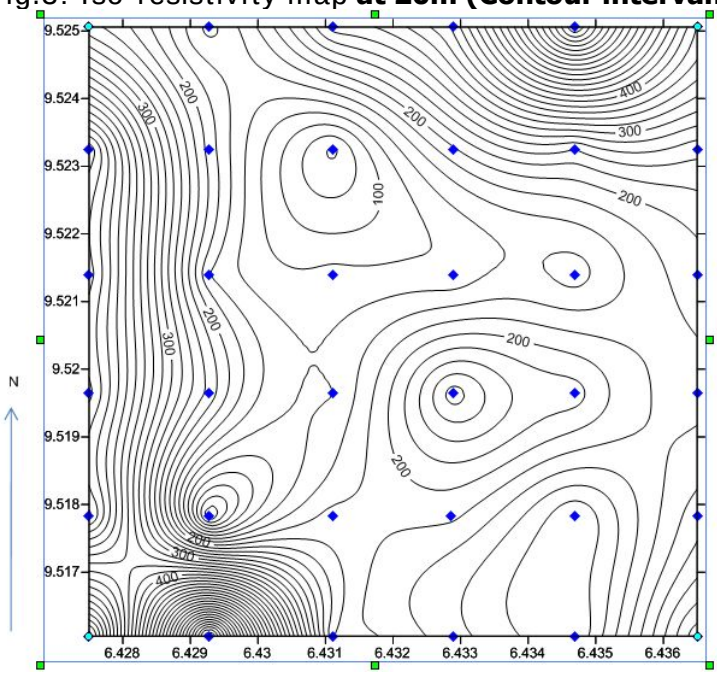

Fig.4: Iso-**resistivity map at 30m (Contour interval: 20Ωm**)

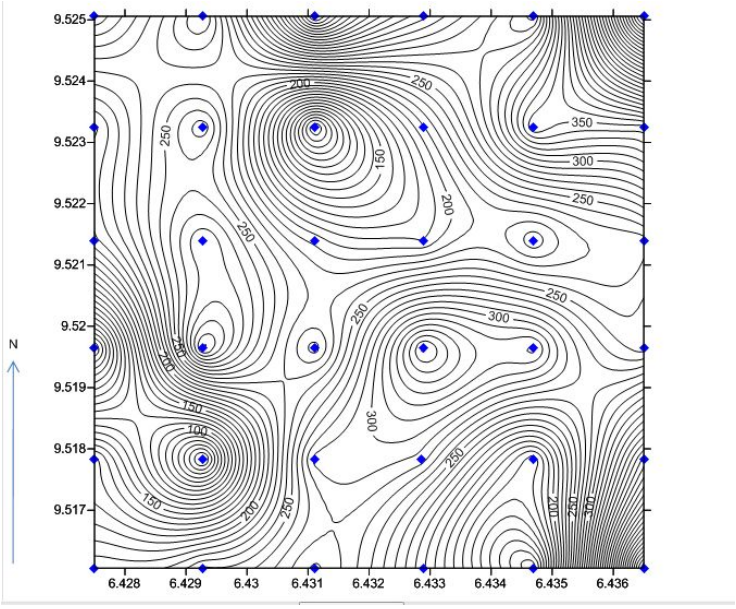

Fig.5: Iso-resistivity map **at 40m (Contour interval: 20Ωm**)

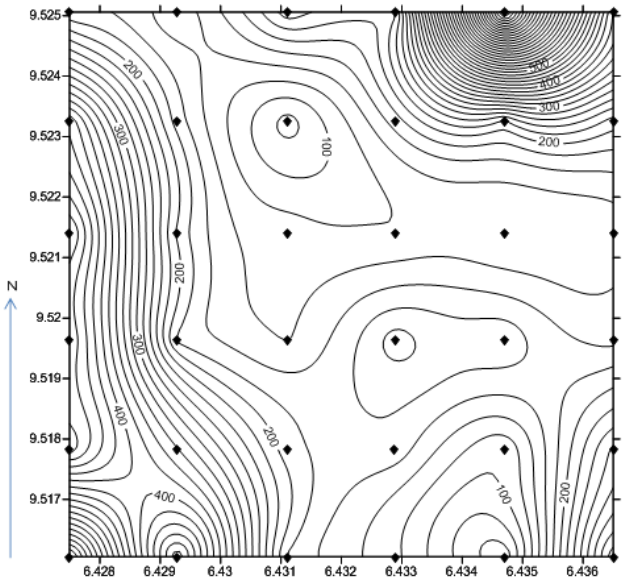

Fig.6: Iso-resistivity map **at 50m (Contour interval: 20Ωm**)

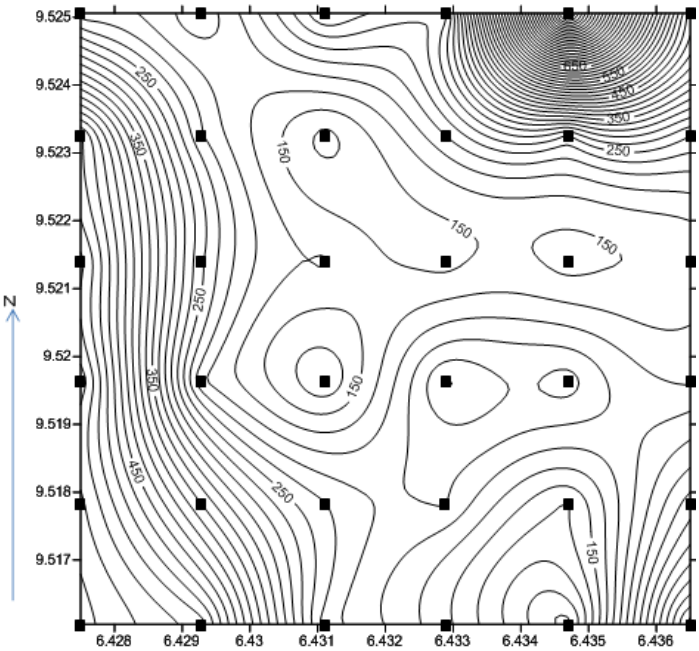

Fig.7: Iso-resistivity map **at 60m (Contour interval: 20Ωm**)

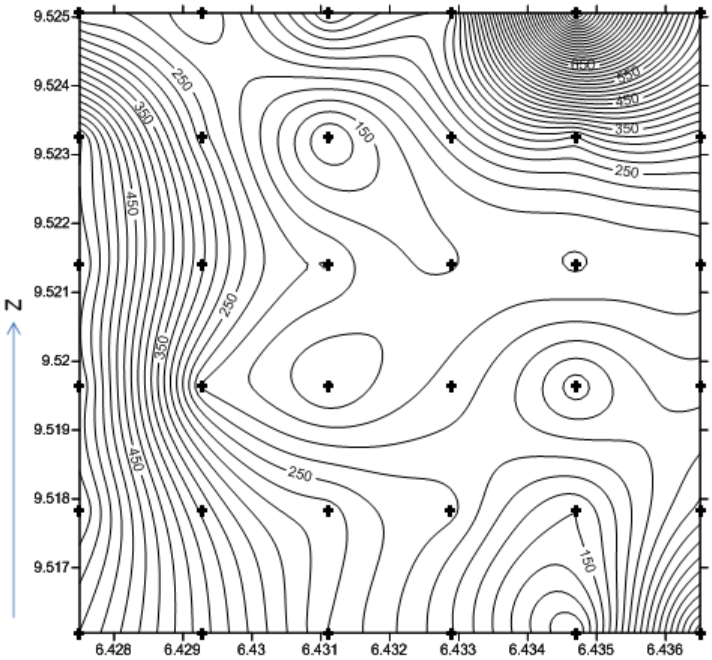

Fig.8: Iso-resistivity map at 70m (**Contour interval: 20Ωm**)

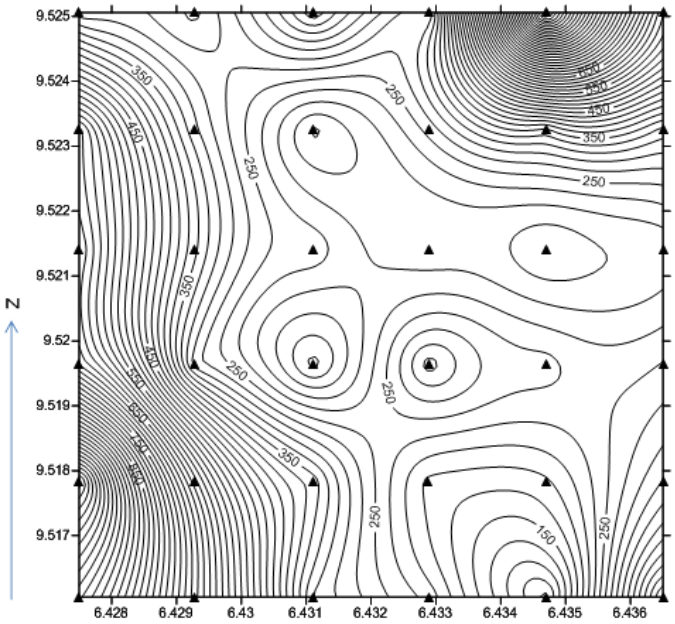

Fig.9: Iso-resistivity map **at 80m (Contour interval: 20Ωm**)

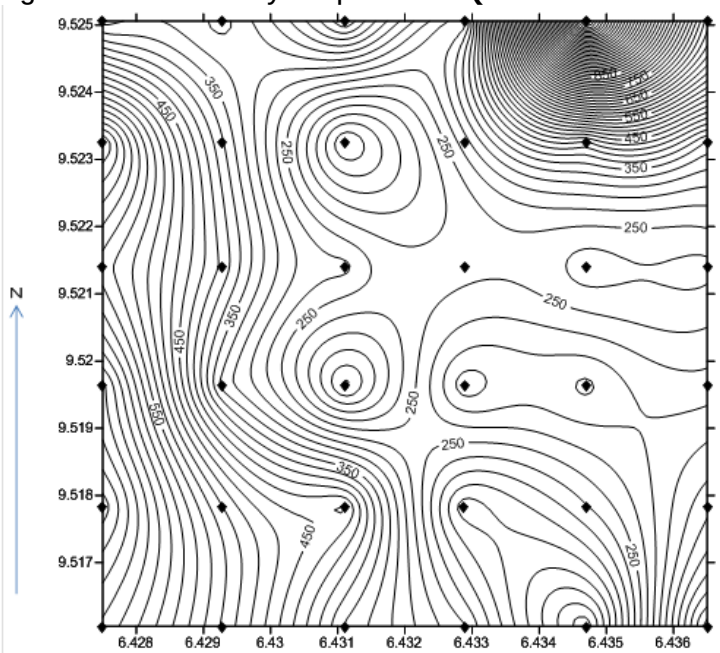

Fig.10: Iso-resistivity map **at 90m (Contour interval: 20Ωm**)

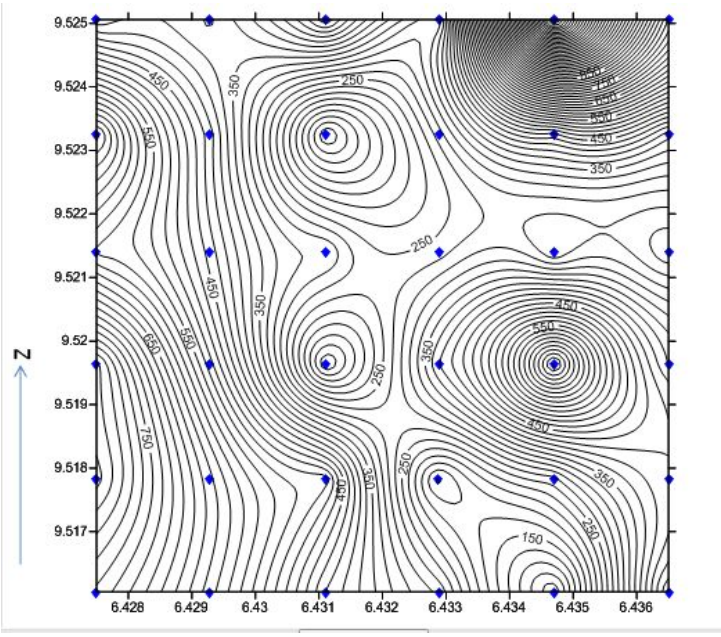

Fig.11: Iso-**resistivity map at 100m (Contour interval: 20Ωm**)

The Surfer® 10 software was also employed to produce a depth map at the area of study, see Fig.12.

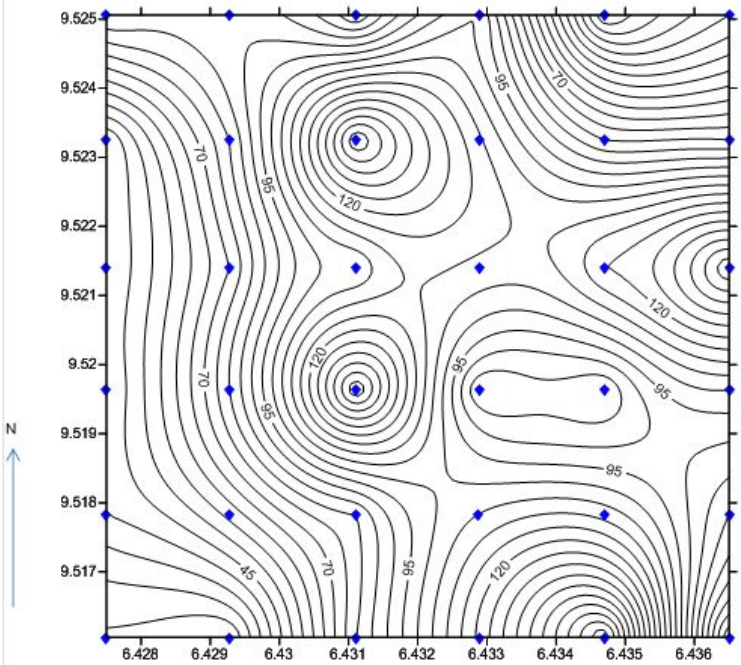

Fig.12: Depth map at the area of study

Discussion of Result

Qualitative Discussion of the Function of the Induced Polarisation Data for the Present Intercalated Survey: The intercalated nature of this present survey implies corroboration, too, of the earlier survey. The results of the earlier survey pinpointed some groundwater prospects (Jonah *et al.*, 2014I). Whilst the result of this present intercalated survey would be subjected to the same basic interpretation techniques like those of the earlier survey, a refinement of sorts herein would be provided by making recourse to the results of the tandem induced polarisation survey on a qualitative basis only. In this case, the interpretation would be guided by the statement-of-fact enunciated on p. 222 of Kearey and Brooks (1984) to wit: the sources of significant IP anomalies are water-filled shear zones; it is understood from ABEM (1999) that IP results can distinguish between groundwater and clay. This property is significant because it constrains the IP method to be an effective discriminator when making deduction as to the presence of groundwater. According to Parasnis (1986), p. 180, "the advantage of IP soundings (as a complement to VES) is that they are able to distinguish between clay layers (high IP) and some other low-resistivity strata like salt-water beds (no IP)." Thus, where it suspected that groundwater may be present, recourse to the corresponding IP value recorded in *pari passu* at that depth would help dispel whatever doubt there may be.

Juxtaposition of the Discussion of Results of the Earlier Survey and the Present Intercalated Survey:

Discussion of Result of the Earlier Survey:- This is as enunciated in (Jonah *et al.*, 2014I).
Discussion of Result of the Present Intercalated Survey:-The "Geoexplore Empirical Standardization for Minna Area" and the "Olasehinde Protocol." It was pointed out earlier that "the result of this present intercalated survey would be subjected to the same basic interpretation techniques like those of the earlier survey." A key reference tool that was germane to the interpretation of the earlier survey was the dual "Geoexplore Empirical Standardization for Minna Area" and the "Olasehinde Protocol." The bases of these protocols have been found to be effective over a two-decade period now for delineating approximate locations of groundwater yield (Olasehinde, 1989; 1999; Muftau Jimoh, personal communication). On the bases of these dual protocols, therefore, TT1-1 is not considered an aquifer prospect; TT1-2 is a good showing up to the 150-m depth, TT1-3 is a good showing up to the 70-m depth, TT1-4 is a good showing up to the 50-m depth, TT1-5 is not considered an aquifer prospect, TT1-6 is a good showing up to the depth of the barrier encountered, TT2-1 is a good showing up to the 40-m depth, TT2-2 is a good showing up to the 80-m depth, TT2-3 is a good showing up to the 50-m depth, TT2-4 is a good showing up to the 50-m depth, TT2-5 has incomplete information, TT2-6 is not a prospect. TT3-1 is a good showing up to the 60-m depth; TT3-2 is a good showing up to the 50-m depth, TT3-3 is a good showing up to the 40-m depth, TT3-4 is a good showing up to the 110-m depth, TT3-5 is a good showing up to the 60-m depth, TT3-6 is not a good showing, TT4-1 is a good showing to the 80-m depth, TT4-2 is a good showing to the 80-m depth, TT4-3 is a good showing to the 80-m depth, TT4-4 is a good showing to the 60-m depth, TT4-5 is a good showing to the 50-m depth, TT4-6 is not a good showing. TT5-1 is a good showing to the 40-m depth; TT5-2 is a good showing to the 40-m depth, TT5-3 coincided with a wet stream barrier, TT5-4 is a good showing to the 120-m depth, TT5-5 is a good showing to the 50-m depth, TT5-6 is not a good showing, TT6-1 is not a good showing, TT6-2 is not a good showing, TT6-3 is not a good showing, TT6-4 would not be a

good showing down to the 30m, TT6-5 is a good showing to the 70-m depth, and TT6-6 is a good showing to the 50-m depth.

The WinResist® Plots: The WinResist® plots were vital guides to determining the numbers of layers at each survey location and, most important of all for this survey, for extracting information on the depth to basement used in the production of the isopach map of Fig.12.

The Iso-Resistivity Maps at Depths: On the maps of Fig.2 to Fig.11, the transverse traverse (TT) designations are in increasing order from south to north (i.e. TT1 to TT6); each profile unit designation is from east to west (as in TT1-1 to TT1-6). The crosses of these figures form a 6 x 6 matrix. Thus the lowest resistivity value of 20Ωm can easily be made out on the 10m-depth map of Fig.12 at TT5-4. In Fig.13, on the 20m-depth map, TT5-2 to TT5-5 form a linear spread of progressively decreasing resistivity from 100Ωm to 20Ωm. TT4-2 to TT4-5, TT3-2 to TT3-5, and TT2-2 to TT2-5 also mirror this pattern. On the 30m-depth map of Fig.14, TT5-4 stands out as the lowest-resistivity region at 60Ωm in a "sea" of ohmic spikes. On the 40m-depth map of Fig.15, TT5-4, TT2-5, and TT1-2 stand out as the lowest-resistivity regions. TT5-4 and TT1-2 are made out still as the lowest resistivity regions on the 50m-depth map of Fig.16; the resistivity value at TT2-5 increases over this 10m-window enormously. TT4-1 to TT4-4 and TT3-1 to TT3-4 form a region of "associate low-resistivity" at this depth, too. The trend of Fig.16 is continued in Fig.17 for the 60m-depth map; the new "entrant" here is TT1-3 and TT2-2. For the 70m-depth map of Fig.18, the resistivity trend of Fig.17 is exactly imaged here. For the 80m-depth map of Fig.19, for the 90m-depth map of Fig.20, and for the 100m-depth map of Fig.21, the resistivity trend of Fig.17 is exactly imaged here, too.

The Isopach Map: The regions of low resistivity values at depths correlate strongly with the regions of contour closures observed on the isopach map of Fig.12.

Conclusion

It was pointed out that the ground location of a specific station designation of the present survey is exactly 100m to the west of that same specific station designation of that of the earlier survey. In this case, TT1-1 of the present survey is intercalated between TT1-1 and TT1-2 of the earlier survey: TT1-1 of the present survey is exactly mid-point of TT1-1 and TT1-2 of the earlier survey; TT1-1 of the present survey is 100m west of TT1-1 of the earlier survey and 100m east of TT1-2 of the earlier survey.

Along the first TT profile (i.e. TT1), the earlier survey identified the following prospects and their corresponding drill window based on the suite of protocols under consideration:
TT1-3: 30m to 150m aquifer drill window
TT1-4: 30m to 150m aquifer drill window

TT1-3 of the present survey is intercalated between *TT1-3* and *TT1-4* of the earlier survey. The interpretation route adopted for this survey indicated that, for the present survey, TT1-3 is a good showing up to the 70-m depth. Thus, for the 200m-spread of *TT1-3* to *TT1-4*, three VES stations on an east-west line at 100m separation could be drilled for groundwater to the varying total depths (TDs) of *150m*-70m-*150m*. In essence, the stated aim of "plugging the knowledge gap of geological information for intervening 200m-spread station spacing of the earlier survey" has largely been achieved over this 200m-spread. Even though for the present survey, TT1-4 is a good showing up to the 50-m depth, it does not *positively intercalate TT1-4* to *TT1-5* of the

earlier survey because the earlier survey does not identify *TT1-5* as a prospect location based on the dual protocols under consideration. Interestingly, the present survey indicates that TT1-5 is not considered an aquifer prospect! Thus, the 100m-spread between *TT1-5* and TT1-5 and the 100m-spread between TT1-5 and *TT1-6* should not be considered for drilling for groundwater exploitation at all.

Along the second TT profile (i.e. TT2), the earlier survey identified the following prospects and their corresponding drill window based on the suite of protocols under consideration:
TT2-1: 30m to 80m aquifer drill window
TT2-2: 10m to 80m aquifer drill window
TT2-3: 15m to 90m aquifer drill window
TT2-4: 30m to 120m aquifer drill window
TT2-5: 15m to 60m aquifer drill window
TT2-6: 8m to 50m aquifer drill window

For the present survey, TT2-1 is a good showing up to the 40-m depth, TT2-2 is a good showing up to the 80-m depth, TT2-3 is a good showing up to the 50-m depth, TT2-4 is a good showing up to the 50-m depth, TT2-5 has incomplete information, and TT2-6 is not a prospect. Thus, there is *positive intercalation* at 100m-spread from *TT2-1*, through *TT2-2*, *TT2-3*, and *TT2-4*.

Along the third TT profile (i.e. TT3), the earlier survey identified the following prospects and their corresponding drill window based on the suite of protocols under consideration:
TT3-1: 20m to 90m aquifer drill window
TT3-2: 8m to 60m aquifer drill window
TT3-3: 20m to 100m aquifer drill window
TT3-4: 30mm to 80m aquifer drill window

For the present survey, TT3-1 is a good showing up to the 60-m depth; TT3-2 is a good showing up to the 50-m depth, TT3-3 is a good showing up to the 40-m depth, TT3-4 is a good showing up to the 110-m depth, TT3-5 is a good showing up to the 60-m depth, TT3-6 is not a good showing. Thus, there is *positive intercalation* at 100m-spread from *TT3-1*, through *TT3-2*, *TT3-3*, and *TT3-4*; this trend is extended to about 100m beyond *TT3-4* along the linear profile.
Along the fourth TT profile (i.e. TT4), the earlier survey identified the following prospects and their corresponding drill window based on the suite of protocols under consideration:
TT4-1: 20m to 130m aquifer drill window
TT4-2: 20m to 110m aquifer drill window
TT4-3: 40m to 150m aquifer drill window
TT4-5: 20m to 80m aquifer drill window

For the present survey, TT4-1 is a good showing to the 80-m depth, TT4-2 is a good showing to the 80-m depth, TT4-3 is a good showing to the 80-m depth, TT4-4 is a good showing to the 60-m depth, TT4-5 is a good showing to the 50-m depth, and TT4-6 is not a good showing. Thus, there is *positive intercalation* at 100m-spread from *TT4-1*, through *TT4-2*, *TT4-3*, *TT4-*4, and *TT4-5*; this trend is extended to about 100m beyond *TT4-5* along the linear profile.

Along the fifth TT profile (i.e. TT5), the earlier survey identified the following prospects and their corresponding drill window based on the suite of protocols under consideration:

TT5-1: 30m to 90m aquifer drill window
TT5-2: 20m to 90m aquifer drill window
TT5-3: 20m to 80m aquifer drill window
TT5-4: 40m to 80m aquifer drill window
TT5-5: 30m to 80m aquifer drill window
TT5-6: 20m to 50m aquifer drill window

For the present survey, TT5-1 is a good showing to the 40-m depth; TT5-2 is a good showing to the 40-m depth, TT5-3 coincided with a wet stream barrier, TT5-4 is a good showing to the 120-m depth, TT5-5 is a good showing to the 50-m depth, TT5-6 is not a good showing. Thus, there is *positive intercalation* at 100m-spread from *TT5-1*, through *TT5-2*, *TT5-3*, *TT5*-4, and *TT5-5*; this trend is extended to about 100m at *TT5-6* along the linear profile.

Along the sixth TT profile (i.e. TT6), the earlier survey identified the following prospects and their corresponding drill window based on the suite of protocols under consideration:
TT6-1: 5m to 70m aquifer drill window
TT6-5: 30m to 110m aquifer drill window
TT6-6: 30m to 70m aquifer drill window

For the present survey, TT6-1 is not a good showing, TT6-2 is not a good showing, TT6-3 is not a good showing, TT6-4 would not be a good showing down to the 30m, TT6-5 is a good showing to the 70-m depth, and TT6-6 is a good showing to the 50-m depth. The prospect locations of *TT6-1*, *TT6-5*, and *TT6-6* implies a correlation of no-prospects over the 200m-spread between *TT6-1* and *TT6-2*, the 200m-spread between *TT6-2* and *TT6-3*, the 200m-spread between *TT6-3* and *TT6-4*, and the 200m-spread between *TT6-4* and *TT6-5*. Thus, there is *positive intercalation* for no-prospects at 100m-spread from *TT6-1*, through *TT6-2*, *TT6-3*, and *TT6*-4; this trend is extended to about 100m at TT6-4 along the linear profile. *Positive intercalation* for prospects can be made out at 100m-spread between *TT6-5 and TT6-6*.

For the present survey, it can be inferred from the foregoing that based on the dual empirical protocol scheme, the following VES locations are considered good prospects for groundwater: TT1-2, TT1-3, TT1-4, TT1-6, TT2-1, TT2-2, TT2-3, TT2-4, TT3-1, TT3-2, TT3-3, TT3-4, TT3-5, TT4-1, TT4-2, TT4-3, TT4-4, TT4-5, TT5-1 TT5-2, TT5-4, TT5-5, TT6-5, and TT6-6. However, if prevailing economic circumstances dictates that only a very limited number of VES locations could be drilled for boreholes at the area of the present survey, then imposing a constraint involving analysis of the iso-resistivity contour maps of Fig.12 to Fig.21, then the highly prospective VES locations would be TT5-4, TT1-2, TT1-3, and TT2-2.

Now, for the recognised highly prospective VES locations of TT5-4, TT1-2, TT1-3, and TT2-2, how would it be certain that it was freshwater and not clay that is responsible for the observed low resistivity regime at depth? Recourse is made here to the section on the qualitative discussion of the function of the induced polarisation data. Herein, examination of the individual IP tables of values would be undertaken for TT5-4, TT1-2, TT1-3, and TT2-2. This qualitative examination of each of the separate IP tables of values would be done only to a TD of 40m. This 40m-window restriction is due to the fact that, in the larger basement complex region of which the present area of study is but a small constituent, the thicknesses of the different phases of overburden materials never exceed 35m (Jimoh, 1998).

Qualitative Examination of IP Table for TT5-4 (see Table 1): It is observed that a negative chargeability value of -55.4ms exist for TT5-4 at the 40m-depth mark: according to ABEM (1999), negative IP values can only mean that the resistivity of the current layer is less than that of the layer just above it; this trend would be contrary to the theoretical expectation that resistivity should increase as the depth increases for any VES location. Interestingly, above this 40m-depth mark layer (i.e. at the 30m-depth mark) for TT5-4, the absolute IP value of 178ms is much greater than the absolute value of 55.4ms at the 40m-depth. Since Parasnis (1986) pointed out that clay layers correspond to "high IPs", and salt-water beds correspond to "no IPs", it can be inferred that freshwater beds correspond to "low IPs." However, according to Mr. Jonah (personal communication), in his work since 2011 at the greater area of the Phase II Development, what is "high" or "low" IP is a subjective matter depending on the prevailing values of the current survey under analysis. This being the case, the absolute IP value of 178ms at the 30m-depth mark is "high" compared to the absolute value of 55.4ms at the 40m-depth mark (i.e. "low IP"). Based on this reckoning, TT5-4 is a very strong candidate for groundwater prospect at the 40m-depth mark, and the iso-resistivity maps have also indicated a continuation of low-resistivity trend at depths beyond this 40m-depth mark.

Qualitative Examination of IP Table for TT1-2 (see Table 2): At the 40m-depth mark, a chargeability of -9.19ms is observed in contrast to an absolute "high" IP value of 106ms at the 5m-depth mark. The deduction that the clay bed lies atop the water-bearing strata in this situation is not misplaced. Based on this reckoning, TT1-2 is a very strong candidate for groundwater prospect at the 40m-depth mark, and the iso-resistivity maps have also indicated a continuation of low-resistivity trend at depths beyond this 40m-depth mark.

Qualitative Examination of IP Table for TT1-3 (see Table 3): The corresponding observation for the TT1-2 VES table of the TT1-3 location can be made out at the 5m-depth mark and at the 6m-depth mark. The iso-resistivity maps have indicated a continuation of low-resistivity trend at depths beyond the 40m-depth mark for this VES location.

Qualitative Examination of IP Table for TT2-2 (see Table 4): The corresponding observation for the TT1-2 VES table of the TT2-2 location can be made out at the 6m-depth mark and at the 8m-depth mark. The iso-resistivity maps have indicated a continuation of low-resistivity trend at depths beyond the 40m-depth mark for this VES location.

Table 1: Geoelectrical data record sheet for TT5-4

AB/2 (CURRENT)	MN/2 (POTENTIAL)	CHARGEABILITY (mS)	RESISTANCE	CURRENT (I)	STANDARD DEVIATION	STACKS	RESISTIVITY (**Ωm**)
1	.50	-0.047	17.739Ω	100mA	0.26	4	41.864
2	.50	-12.2	235.02mΩ	100mA	0.33	4	2.7730
3	.50	-23.9	64.468 mΩ	100mA	0.82	4	1.7922
5	.50	-26.7	38.619 mΩ	100mA	1.20	4	3.0045
6	.50	-39.9	25.032 mΩ	100mA	5.00	4	2.8035
6	1.00	-26.9	47.019 mΩ	100mA	4.30	4	2.5860
8	1.00	-20.4	32.349 mΩ	100mA	0.73	4	3.2026
10	1.00	-29.4	25.790 mΩ	100mA	0.57	4	4.0233
10	2.50	-16.0	58.415 mΩ	100mA	0.02	4	3.4406
15	2.50	-22.4	38.522 mΩ	100mA	1.30	4	5.2770
20	2.50	-35.0	29.240 mΩ	100mA	1.80	4	7.1631
30	2.50	-178	55.315 mΩ	100mA	5.50	4	31.087
40	2.50	-55.4	15.823 mΩ	100mA	11.0	4	15.015

40	7.50	10.8	76.541 mΩ	100mA	1.90	4	24.722
50	7.50	2.22	140.49 mΩ	100mA	2.80	4	71.915
60	7.50	-3.32	165.57 mΩ	100mA	5.30	4	122.85
70	7.50	0.19	105.01 mΩ	100mA	4.50	4	106.48
80	7.50	11.3	149.67 mΩ	100mA	3.20	4	198.91
80	15.00	11.3	204.50 mΩ	100mA	1.30	4	132.31
90	15.00	-0.89	152.77 mΩ	100mA	1.40	4	126.04
100	15.00	37.7	65.918 mΩ	100mA	3.50	4	67.499
110	15.00	-5.88	95.272 mΩ	100mA	0.03	4	119.08
120	15.00	-21.3	117.22 mΩ	100mA	1.10	4	173.95
130	15.00	-3.97	123.25 mΩ	100mA	0.55	4	215.30
150	15.00	-23.3	146.10 mΩ	100mA	0.05	4	340.93
170	15.00	25.4	56.223 mΩ	100mA	7.20	4	168.88
200	15.00	8.53	30.094 mΩ	100mA	0.85	4	125.38

Table 2: Geoelectrical data record sheet for TT1-2

GEOELECTRICAL DATA RECORD SHEET

TYPE OF SURVEY:..Induced Polarisation/Resistivity..**MODE:**..Time domain/VES.. **ARRAY:** ..Schlumberger…….

PLACE:..Gidan Kwano Campus.. **WEATHER:**Sunny…….. **EQUIPMENT:**.ABEM Terrameter SAS 4000

LOCATION: (i) **N:**09°30'57.8''.....(ii) **E:**006°26'04.92''.....**ELEVATION:**202m…….

OPERATOR:……**RECORDER:**…… ……**DATE:**12/05/2014……..…**TIME:**02:18 PM……

TRANSVERSE TRAVERSE DESIGNATION:..TT1-2…… **GPS UNIT:**… Garmin GPSmap72…….

AB/2 (CURRENT)	MN/2 (POTENTIAL)	GEOM. FACTOR, K	CHARGEABILITY (mS)	RESISTANCE	STANDARD DEVIATION	CURRENT (I)	STACKS	RESISTIVITY (Ωm)
1	.50	2.36	-1.12	3.434 mΩ	0.64	50mA	4	0.008
2	.50	11.8	-2.38	519.78 mΩ	0.44	100mA	4	6.133
3	.50	27.8	-0.26	237.32 mΩ	0.12	100mA	4	6.597
5	.50	77.8	-108.0	-63.81 mΩ	-12.53	100mA	4	4.964
6	.50	112	3.65	74.537 mΩ	1.70	100mA	4	8.348
6	1.00	55	0.91	160.41 mΩ	1.00	100mA	4	8.823
8	1.00	99	1.93	102.59 mΩ	1.50	100mA	4	10.156
10	1.00	156	8.26	73.066 mΩ	2.60	100mA	4	11.398
10	2.50	58.9	1.10	242.96 mΩ	0.79	100mA	4	14.310
15	2.50	137	-19.60	257.16 mΩ	2.40	100mA	4	35.230
20	2.50	245	-5.61	134.20 mΩ	1.90	100mA	4	32.879
30	2.50	562	-14.30	100.77 mΩ	2.60	100mA	4	56.632
40	2.50	1001	-20.40	48.35 mΩ	7.20	100mA	4	48.398
40	7.50	323	-9.19	151.42 mΩ	0.31	100mA	4	48.908
50	7.50	512	0.88	89.63 mΩ	2.90	100mA	4	44.355
60	7.50	742	-5.97	82.29 mΩ	20.00	100mA	4	61.059
70	7.50	1014	-2.60	64.99 mΩ	3.10	100mA	4	65.899
80	7.50	1329	25.20	35.89 mΩ	5.70	100mA	4	47.698
80	15.00	647	8.35	120.99 mΩ	0.92	100mA	4	78.281
90	15.00	825	2.20	88.81 mΩ	2.20	100mA	4	73.268
100	15.00	1024	209.00	49.50 mΩ	5.70	100mA	4	50.688
110	15.00	1244	25.40	13.63 mΩ	20.00	100mA	4	16.955
120	15.00	1484	22.80	36.02 mΩ	14.00	100mA	4	53.454
130	15.00	1746.90	-26.60	31.125 mΩ	6.90	100mA	4	54.372
150	15.00	2333.57	-35.00	85.33 mΩ	3.80	100mA	4	199.124
170	15.00	3004.09	-15.6	100.21 mΩ	9.20	100mA	4	301.040
200	15.00	4166.91	43.60	37.79 mΩ	6.80	100mA	4	157.468

Table 3: Geoelectrical data record sheet for TT1-3

AB/2 (CURRENT)	MN/2 (POTENTIAL)	CHARGEABILITY (mS)	RESISTANCE	CURRENT (I)	STANDARD DEVIATION	STACKS	RESISTIVITY (**Ωm**)
1	.50	0.67	13.614Ω	100mA	0.02	4	32.129
2	.50	0.52	2.0487Ω	100mA	2.70	4	24.166
3	.50	0.52	716.24mΩ	100mA	0.06	4	19.911
5	.50	1.15	157.27 mΩ	100mA	1.20	4	12.236
6	.50	-0.012	163.65 mΩ	100mA	0.12	4	18.329
6	1.00	-1.27	294.90 mΩ	100mA	1.10	4	16.219
8	1.00	1.28	197.39 mΩ	100mA	0.38	4	19.542
10	1.00	1.38	153.06 mΩ	100mA	0.07	4	23.877
10	2.50	1.78	497.12 mΩ	100mA	0.13	4	29.280
15	2.50	1.81	296.90 mΩ	100mA	0.24	4	40.675
20	2.50	2.01	215.58 mΩ	100mA	0.16	4	52.817
30	2.50	10.7	147.54 mΩ	100mA	0.23	4	82.917
40	2.50	1.72	119.24 mΩ	100mA	0.25	4	119.35
40	7.50	2.44	303.95 mΩ	100mA	0.30	4	98.175
50	7.50	2.55	243.92 mΩ	100mA	0.37	4	124.88
60	7.50	1.38	208.99 mΩ	100mA	0.29	4	155.07
70	7.50	0.38	189.67 mΩ	100mA	0.21	4	192.32
80	7.50	0.86	173.65 mΩ	100mA	0.80	4	230.78
80	15.00	0.23	333.05 mΩ	100mA	0.01	4	215.48
90	15.00	2.01	305.60 mΩ	100mA	0.25	4	252.12
100	15.00	1.58	278.61 mΩ	100mA	0.66	4	285.29
110	15.00	NATURAL	CONSTRAINT	AT	DISTANCE	NATURAL	CONSTRAINT
120	15.00	NATURAL	CONSTRAINT	AT	DISTANCE	NATURAL	CONSTRAINT
130	15.00	NATURAL	CONSTRAINT	AT	DISTANCE	NATURAL	CONSTRAINT
150	15.00	NATURAL	CONSTRAINT	AT	DISTANCE	NATURAL	CONSTRAINT
170	15.00	NATURAL	CONSTRAINT	AT	DISTANCE	NATURAL	CONSTRAINT
200	15.00	NATURAL	CONSTRAINT	AT	DISTANCE	NATURAL	CONSTRAINT

Table 4: Geoelectrical data record sheet for TT2-2

AB/2 (CURRENT)	MN/2 (POTENTIAL)	CHARGEABILITY (mS)	RESISTANCE	CURRENT (I)	STANDARD DEVIATION	STACKS	RESISTIVITY (**Ωm**)
1	.50	0.25	10.792Ω	100mA	0.01	4	25.469
2	.50	0.42	730.95mΩ	100mA	0.15	4	8.6250
3	.50	0.024	370.35 mΩ	100mA	0.11	4	10.295
5	.50	-3.44	161.01 mΩ	50mA	0.69	4	12.527
6	.50	-2.51	876.45 mΩ	50mA	2.70	4	98.162
6	1.00	2.17	249.36 mΩ	50mA	0.74	4	13.714
8	1.00	-0.99	181.56 mΩ	50mA	0.36	4	17.974
10	1.00	1.30	108.20 mΩ	100mA	0.31	4	16.879
10	2.50	-0.52	320.69 mΩ	100mA	1.10	4	18.889
15	2.50	-2.96	188.95 mΩ	50mA	0.63	4	25.886
20	2.50	1.37	143.46 mΩ	50mA	0.78	4	35.147
30	2.50	31.2	99.466 mΩ	50mA	1.20	4	55.899
40	2.50	27.6	75.905 mΩ	100mA	2.20	4	75.976
40	7.50	1.84	249.76 mΩ	100mA	0.37	4	80.672
50	7.50	-31.1	200.72 mΩ	100mA	3.20	4	102.77
60	7.50	-8.11	172.83 mΩ	100mA	0.26	4	128.24
70	7.50	-7.90	147.94 mΩ	100mA	1.30	4	150.01

80	7.50	2.79	132.88 mΩ	100mA	1.80	4	176.59
80	15.00	0.39	301.87 mΩ	100mA	0.45	4	195.31
90	15.00	2.16	276.60 mΩ	100mA	0.12	4	228.20
100	15.00	14.0	256.76 mΩ	100mA	0.34	4	262.92
110	15.00	NATURAL	CONSTRAINT	AT	DISTANCE	NATURAL	CONSTRAINT
120	15.00	NATURAL	CONSTRAINT	AT	DISTANCE	NATURAL	CONSTRAINT
130	15.00	NATURAL	CONSTRAINT	AT	DISTANCE	NATURAL	CONSTRAINT
150	15.00	NATURAL	CONSTRAINT	AT	DISTANCE	NATURAL	CONSTRAINT
170	15.00	NATURAL	CONSTRAINT	AT	DISTANCE	NATURAL	CONSTRAINT
200	15.00	NATURAL	CONSTRAINT	AT	DISTANCE	NATURAL	CONSTRAINT

Recommendation

Now that attention is being focused on the exploitation of groundwater resource at the Phase II Development of the Gidan Kwano Campus as an interim measure, it is recommended that for the 200m-spread of *TT1-3* to *TT1-4*, three VES stations on an east-west line at 100m separation could be drilled for groundwater to the varying total depths (TDs) of *150m*-70m-*150m*. Also, the VES locations *TT2-1*, *TT2-2*, *TT2-3*, and *TT2-4* could be drilled for groundwater at 100m linear spread. Drilling for groundwater is also recommended for the VES locations *TT3-1*, *TT3-2*, *TT3-3*, *TT3-4*, and 100m beyond *TT3-4* along the linear profile for the 100m-spread.

Along TT4, drilling for groundwater is recommended for the 100m-spread from *TT4-1*, through *TT4-2*, *TT4-3*, *TT4*-4, and *TT4-5*; this could be extended to about 100m beyond *TT4-5* along the linear profile. For TT5, drilling for groundwater is recommended for the 100m-spread from *TT5-1*, through *TT5-2*, *TT5-3*, *TT5*-4, and *TT5-5*; this could be extended to about 100m at *TT5-6* along the linear profile.

Transverse traverse number six (TT6), the northernmost traverse line of this survey, does not present such straightforward drill prospects. Drilling for groundwater prospect should not be carried out for the 100m-spread over the linear distance from *TT6-1*, through *TT6-2*, *TT6-3*, and *TT6*-4; this recommendation for drilling restriction extends to 100m linear spread to the west of *TT6*-4 (this is the equivalent of TT6-4 of the present survey). If drilling must be done at all along TT6, then it should be between *TT6-5 and TT6-6* at 100m-spread encompassing the mid-point location of TT6-5 of the present survey, as well as 100m beyond *TT6-6* to correspond to the location of the present TT6-6.

If prevailing economic circumstances precludes the drilling of a large number of boreholes at the area of the present survey, then it is recommended that only the VES locations of TT5-4, TT1-2, TT1-3, and TT2-2 be drilled for groundwater exploitation.

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MISCONCEPTION: A NEGATIVE INFLUENCE ON THE PERFORMANCE OF SS3 CHEMISTRY STUDENTS

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Abstract
This paper investigated twenty chemistry concepts using Basic Chemistry Misconception Identification (BCM) tool as instrument. One hundred (100) responses were received from two senior secondary school students chosen randomly in Minna, Niger State, Nigeria. Degrees of misconception were identified with their extent as scores. The highest level was on the effect of the change in pressure on the position of equilibrium 55.6% the lowest level was on the electron with 5.5%.HO: which states that there is no significant difference on the performance of students with low and high degrees of misconceptions was rejected. By extension it was identified that misconceptions might have negative influence on the performance of high/low achievers. Consequently, misconceptions have a negative performance on SS3 students.

Keywords: Misconception, Negative-influence and Negative achievement.

Introduction
Tobias (1987) reported that generally in learning of science, there are several types of misconceptions. An effective chemistry teacher is believed to first identify the type of student misconception before the student can be helped (Robert, 2000). It is an essential component to first identify the nature of students misconception before the problem can be overcome (Robert, 2000; Poster *et al.,* 1982). Preconceived notions of the everyday activities mostly are rooted right from childhood, especially when exploring knowledge from their immediate surroundings, they tend to structure ideas in an attempt to explain some phenomena in their own terms and also share their explanations (Terry *et al.,* 1985; Tobias, 1987; Wandersee *et al.,* 1994). The explanations are carried on and even passed to higher levels. In some children a good percentage of assumptions used in explanations are wrong preconceptions and therefore are misconceived (Robert, 2000).

Carter and Brick-House (1989) reported that many students say that chemistry is difficult. These perceived difficulties are part of the context in which these students develop chemical concepts and problem solving skills. Basically the theoretical content of chemistry has been reported by Nahum *et al.,* (2004) as best seen as a set of models. In the same vein Gilbert (1998) claims that models play a major role in all science disciplines however the models appear to be giving students' problems. Nahum *et al.,* (2004) describes the environment students find themselves as macroscopic world of matter in which chemistry is never perceived to be related to their immediate surroundings. In addition, John Stone, (1991); Gabel, (1996); Tsapalis, (1997); Robinson, (2003); Nahum *et al.,* (2004) reported that students do not easily transit; canonically from macroscopic to microscopic environmental imaginations. Chemical concepts are naturally abstracts and students find it difficult to explain chemical phenomena and even some terminologies, using widely embraced concepts (Nahum *et al.,* 2004). However,

Gabel (1996) has reported that "The complexity of chemistry has implications for the teaching of chemistry today and that chemistry is a very complex subjects from both the research on problem solving and misconception and from our own experience students posses these misconceptions not only because chemistry is complex, but also because of the way the concepts are taught".

Aim and Objectives

This study seeks to achieve the following:-

(i) Correlate the mean scores of low and high achievers,
(ii) Find the levels of misconceptions of low and high achievers,
(iii) Correlate levels of misconceptions in chemistry concepts with the performance of Senior Secondary 3 students.

Hypothesis

HO: There is no significant difference on the performance of students with low and high degree of misconception.

Research Methodology

Final year senior secondary school students (SSS 3) were the population targeted in this research. Two senior secondary schools were chosen randomly from Minna, Niger State capital, Nigeria. A total of one hundred and ninety three (193) students consisting of ninety (90) boys and one hundred and three (103) girls were drawn from the two schools to serve as samples.

The instrument used for the research was Basic Chemistry Misconception Identification Instrument (BCMI). This consists of twenty (20) questions from basic chemistry concepts. The basic chemistry concepts include: atoms, molecules, compounds, mixtures, cations, anions, atomic number, mass number, electron, element, Le-Chartelier's principles, chemical equilibrium, equilibrium constant, effect of change in pressure on the equilibrium position of an esterification reaction in aqueous state, effect of change in pressure on the equilibrium position of an inorganic reaction in gaseous state, effect of increase in temperature on the equilibrium position of the reaction in gaseous state, effect of increase in concentration of iron on the equilibrium position of the reaction, expression for equilibrium constant, exothermic and endothermic reaction. The instrument was content validated by three specialist; one science education specialist, two chemistry teachers (one from college of education and one from secondary school). Finally, the format and content of the instrument were written as suggested by the validators. The reliability of measuring instrument was determined using test-retest technique. The items were administered to the students who were not participants in the main study. The reliability coefficient of the instrument was found to be 0.82. Thus, the instrument was adopted for the study.

The randomly selected schools from which the samples of the study were drawn were first visited by the researcher to obtain permission to use the schools for the study. The students in each school were randomly selected after proper introduction and explanation on the purpose of the test. The instrument was then administered to the students the following day. The responses of the students were collected and scored. A correct answer was scored 3 points while misconception and wrong answer were scored 2 and 1 respectively. A response was scored as correct if it is the same as stated in the marking scheme or anybody of words that conveys the same meaning as the correct answer. A response that was misunderstood was

taken as a misconception while a response that was irrelevant was taken as wrong answer. The sample students were further split up into two. The high achievers, students with minimum misconception and low achievers; students with high degree of misconception. The scores of the two split half from the bases of finding the mean, standard deviation and t-test (Jimoh, 2002; Evan *et al.,* 2003).

Results

The methods adopted to analyze the raw scores are percentage, group means, deviation and t-test. The percentage was used to answer the research questions, while the t-test was used to test for the hypothesis of the study.

Table 1: Representation of levels of misconceptions identified

Basic chemistry concepts	Misconception identified	N	X	ΣX	%
Atoms	Atoms can be seen with powerful instruments.	11	22		24.4
	Atoms move so have live	03	16		17.8
	Every atom has their respective electrons.	09	18		20.0
	Atoms are like cells with membrane and nucleus	09	18	90	
	Nuclear reactions in atoms are like reproduction in animals.	09	16		17.8
Molecules	Molecules exist singly generally.	09	18		18
	Molecules of solids are harder than molecules of liquid and in terms are harder than those of gases.	11	22		22
	Molecules of solids appear to be bigger than those of liquids.	13	26	100	26
	Molecules of solid have cubic shape while molecules of liquids are round in shape.	17	34		34
Compounds	Compounds are always serving as reactants.	10	20		22.2
	Compounds are mixtures of different elements.	15	30		33.3
	Compounds are made up of two or more immiscible substances.	07	14		15.6
	Compound are generally salts	08	16	90	17.8
	Every chemical is a compound	05	10		11.1
Mixtures	Combination of two or more different elements	09	18		22.5
	Addition of two more substances.	11	22		27.5
	Any mixture that is easily separated.	08	16	80	20
	Addition of two or more different compounds.	12	24		30.0
Cations	Cations are negatively ions	08	16		53.3
	Cations move faster and stronger than anions.	07	14	30	46.7
Anions	Anions are positive ions.	07	14		47.7
	Anions are faster and stronger than cations.	08	16	30	53.3
Atomic Number	Number in periodic table.	10	20		22.2
	Number derived from the main groups of periodic table.	10	20		22.2
	The total number of protons and neutrons in atoms.	10	20	90	22.2
	The total number of proton and electron in the nucleus.	15	30		33.3

	The total number of electron and protons.	13	26		6
Mass Number	The number of neutrons present in an element.	12	24	100	24
	The number of element derived from atomic number.	11	22		22
	The number represented by A.	14	28		28
Electron	Any substance negatively charged and can move.	19	38		27.3
	Total number of changes in elements.	23	46		41.8
	The charge present in substance.	10	20	110	18.2
	Any particle that can bear charge in atoms.	03	06		05.5
Elements	Any substance that can not be divided unless by chemical means.	11	22		24.4
	Substances that can take part in chemical reaction.	11	22		24.4
	Any substance that can not be split into simpler ones in chemical reaction.	14	28	90	31.1
	Any substance that cannot exist alone.	09	18		20.0
Chartelier's Principles	Energy of a reversible reaction attains specific equilibrium under given condition.	15	30		22.22
	Effect of temperature, pressure concentration change is always cancelled in reaction.	10	20	90	22.2
	Equilibrium position does not depend on state of reaction.	20	40		44.4
Chemical Equilibrium	Gibbs free energy is the same as chemical equilibrium at zero temperature.	15	30		27.3
	State attained when reactions are balanced.	13	26		23.6
	A process not a state.	10	20	110	
	A system which total sum of reactants is equal to products.	17	34		30.9
Equilibrium Constant	Expresses constant Equilibrium position.	25	50		41.7
	Depicts values of constant system in equilibrium.	15	30		25.0
	Expresses quantity of catalyst used in reactions.	20	40	120	33.3
Effect of change in pressure on equilibrium position (gases)	Taking the effect as the same as that of temperature.	25	50		55.6
	Opposite application of the change in equilibrium position.	20	40	90	44.4
Effect of change in pressure in equilibrium position (Liquid)	Liquids state taken as gaseous state.	48	96		60.0
	The states in chemical reaction as often ignored.	32	84	180	40.0
Effect of the increase in temperature on equilibrium	Equilibrium alone is used for equilibrium position.	25	50		41.7
	Prediction of effect in opposite direction.	35	70	120	58.3
Effect of the increase in	Prediction of effect in opposite direction.	40	80		61.5
	Taking concentration for temperature.	25	50		38.5

concentration product on equilibrium position				130	
Expression of equilibrium constant	Expression by exchanging the numerator for denominator.	15	30	50	60.0
	Taking equilibrium constant to be mistaken for chemical equilibrium.	10	20		40.0
Exothermic reaction	Expressed as exothermic reactions.	10	20	20	100
Endothermic Reaction	Expressed as endothermic reaction.	10	20	20	100

Where N is the number of students, X as score ∑X as total sum of scores and percentage (%) of each identified basic chemistry concept. Table 1 above shows the summary of misconception identified on each of basic chemistry concepts. Thirteen out of twenty concepts investigated have percentage of misconception that is significantly classified to be of high degree as each have percentage of misconception 40% and above. The concepts include: Molecules, Compounds, Mixtures, Mass Number, Electron, Element, Le Chartelier's principles, Chemical equilibrium. Equilibrium constant, effect of change in pressure on equilibrium position (liquid), effect of increase in temperature on equilibrium position and effect of increase in concentration of product. While seven of the basic chemistry concepts, atoms, cations, anions, atomic numbers, expression of equilibrium. Constant, exothermic and endothermic reactions have percentage of misconceptions classified to be of low degree as their percentage of misconception are less than 40% (Jimoh, 2002; Evans *et al.,* 2003, Bailey and Garratt, 2002). The two parallel trends are not surprising because, basically concepts that are taught by repeated canonical lecture formal where there exist limited involvement of students to the learning process rather than the statement instructional mode of lecture which is reported to be more effective with respect to achievement of learning activities (John stone, 2000, Bailey and Garrant, 2002). The above trend observed from the research further reinforced the findings of Akinsola and Igwe (cited in Mohammed, 2005) that the chemistry terminologies such as molecules, compounds, mixture, mass number, electron, element, Chartelier principles, chemical equilibrium, equilibrium constant sort to explore from the students strong conceptual metal models, consequently the high degree of their percentage of 40% and above. However, the concepts like atoms, cations, anions, atomic number, and expression do not to a large extent require strong conceptual mental model from students' therefore low degree of misconceptions less than 40%. These varying degrees are corroborated by the report of Pavelich *et al.,* (2004) that students often solve scientific problems in a course but have very poor mental model understanding on the concept, which fundamentally shows the low achievement of learning for the knowledge transferred from teachers and these opinions are reinforced by Jimoh, (2002); Orji, (cited in Mohammed, 2005); Evan *et al.,* (2003); Mulfold and Robinson (2002) on their studies of misconception of different science concepts.

Table 2: t-test comparisons of law and high degree misconceptions students

Group	No. of students	Df	X	SD	t-cal	t-critical
Low degree misconception students (High Achievers)	55	98	52.3	12.8	16.4	1.66
High degree misconception students (Low Achievers)	45		18.9	7.1		

Conclusion

Table 2: Presents the t-test comparisons of low and high degree misconceptions students. The mean score for the high achievers (Low degree misconceptions students) was 52.3 and that of the low achievers (high degree misconception students) was 18.9. The calculated t-value of 16.4 is greater than the t-critical value (1.66). This indicates that there is statistically significant difference between the mean scores of the high achievers (52.3) and low achievers (18.9) at the 0.05 level (t-16.4, df – 98, P < 0.0). Hence, HO, which state that there is no significant difference on the performance of students with low degree and high degree of misconception was rejected. Consequently, there is significant difference on performance of students with low degree and high degree of misconception. It could be deduced from the result that subscript on basic chemistry concepts have a negative effect on the performance of students. This is in line with the findings of John stone (1991), Novak (1998); Taber (2000); Kousathana and Tsaparrlis (2002); Pavelich *et al.,* (2004) on the their research as there exist key fundamental concepts that are prerequisite to main to main topic which if ignored could be responsible for gross degrees of misconception amongst students.

The calculated t-value of 16.4 is significant at 0.05 level (P = 0.05) indicating that the research hypothesis that, there is no significant difference between the mean scores of low degree misconception (high achiever) and high degree misconception (low achiever) students was rejected. The implication when the mean score for the high achievers (52.3) and that of the low achievers (18.9) are compared in addition the critical t-value (1.66) compound with calculated t-value 16.4 shows clearly remarkable statistical significant difference between the two groups. Consequently there is significant difference on the performance of students with low varying level of misconception, the low achievers and the high achievers. It could therefore be implied that misconception on basic chemistry concepts has a negative effect on the performance of students. This in no small measure shows that the presence of misconception on particularly the basic fundamental terminologies in all aspect will affect the assimilation of the more advanced part of the subject. This result reinforced the findings of Lythcott (1990); Gabel (1996); Kelvin (1996); Perkin (1995); Hewson and Hewson (1991); Robert (2000) and Novak and Godwin (1984) that misconception on the fundamental terms if not cleared are usually passed from lower level to even higher levels. Le Chartelier's principle in practical classroom learning activity, bugs students owing to its limited character constrain, vagueness and ambiguity in its formulation, consequently the principles is widely misapplied. Therefore the result of this research is not surprising that the application of Le Chartelier's principle having highest misconception percentage of 84.2%. hence, it has become necessary to recommend the replacement of Le Chartelier's principles with a more plausible, easy, and functional approach like Equilibrium law.

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APPLICATIONS OF ARTIFICIAL INTELLIGENCE TECHNIQUES IN COGNITIVE RADIOS: A SURVEY

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Abstract
Advances in radio technology have led to the proliferation of a smart software radio device called Cognitive Radio (CR). The radio integrates several techniques taken from information theory, statistical signal processing, game theory, artificial intelligence to wideband/multiple antenna techniques in providing marvellous dynamic behaviour by enriching the transceivers with desirable properties such as capability of learning, adaptability and self awareness thus enabling technology for Next Generation wireless systems. This paper presents a survey of various Artificial Intelligence (AI) techniques which are utilized in CR implementations with the goal of examining their strength, weakness and open research issues. AI techniques review in this paper includes the Genetic Algorithms (GA), Artificial Neural Networks (ANNs), Hidden Markov Models and the Metaheuristic Algorithms. In addition, the paper examined various areas of applications of ANNs and their performance based metrics.

Keywords: Artificial Intelligence, Artificial Neural Networks, Cognitive Engine, Cognitive Radio and Genetic Algorithms

Introduction
The increasing growth in wireless communications technologies and the emergence of new devices and services associated with wireless communications in offices, homes and public zones have led to a further demand of frequency spectrum (Mitola, 2000; NCC, 2014; Odufuwa, 2010). The current technique of allocating fixed portions of spectrum to each service provider i.e., the traditional spectrum licensing model, where a spectrum regulator (e.g. Nigerian Communications Commissions (NCC) in Nigeria), allocates spectrum by assigning exclusive licenses to service providers to operate their networks on different bands (NCC, 2014) is not cost-effective. This is because a licensee may not always put every part of his band to use. Moreover, some outdated wireless services no longer effectively use their allotted spectrum bands. Therefore, a band lies idle when not in use by the license holder, which gives the false impression of spectrum scarcity (Mitola, 1999) to other users.

Advances in radio technology have led to the proliferation of a smart software radio device called Cognitive Radio (CR) which is the key enabling technology for Next Generation wireless systems (Akyildiz, Lee, Vuran, & Mohanty, 2006). This type of radio integrates several techniques ranging from information theory, statistical signal processing, game theory, artificial intelligence to wideband/multiple antenna techniques in providing marvellously intelligent and dynamic behavior by enriching the transceivers with desirable properties such as capability of learning, adaptability and self awareness (Akyildiz, et al., 2006). This CR has been proposed as an enabling technology that can effectively combat the under utilization of frequency spectrum,

which might result in the imminent spectrum scarcity problem by enabling user's access to spectrum dynamically and fairly shares the spectrum with other users (Mitola, 1999, 2000). It promises intelligent radios that can learn from and adapt to their environment by using a smart technique based on cumulative learning to decide on which spectrum it can opportunistically utilize (Akyildiz, et al., 2006).

A CR can be taken as a paradigm for wireless communication in which either a network or a wireless node dynamically changes its transmission or reception parameters in order to communicate efficiently in a licensed band without interference with licensed users (Mitola, 2000). Therefore, a CR is fundamentally a type of software radio with additional capabilities and functionalities such as environment sensing, learning and decision-making which necessitate its attainment of the required dynamic performance. The extreme flexibility of CR, which includes adaptation to any channel condition, facilitates its easy coexistence with numerous other communication systems. It does this by changing its operating parameters such as modulation scheme and channel coding to achieve the highest possible level of quality of service (Akyildiz, et al., 2006; He, Bae, Newman, Gaeddert, Kim, Menon, Morales-Tirado, Neel, Zhao, & Reed, 2010). These CR emanated from the advancement of software radio technology with cognitive capabilities. Usually, these capabilities are provided by an intelligent instantiation of a software package called cognitive engine (CE) (He, et al., 2010).

CE is the intelligent agent of CR, hence can be regarded as the brain of CR. The CE uses the policy and goals to determine an appropriate utility function by putting the specific application or radio scenario into consideration (Katidiotis, Tsagkaris, & Demestichas, 2010). The most efficient reasoning and learning technique can be chosen by the CE by leveraging on past experience and knowledge. The CE can utilize this strength to make optimal and or cross layer adaptation subject to regulation, policy and radio equipment capability constraints. The feedback performance is collected by sensing the environment or from other radio nodes thus enabled the closure of the CE learning loop. The radio environment mapping, case library and knowledge base are updated based on the observed performance result (Katidiotis, et al., 2010; Rewagad & Soanawane, 1998).

There exist various forms of Artificial Intelligence (AI) techniques that can be applied to the design of CR systems. These include the Artificial Neural Networks (ANNs), Genetic Algorithms (GA), Metaheuristic Algorithms and the Hidden Markov Models. These AI techniques can be used to achieve the fundamental components of a CR viz awareness, learning and reasoning. This paper presents a survey of various AI techniques that are utilized in CR implementations with special emphasis on ANNs techniques. Furthermore, the paper examines various areas of applications of ANNs and their performance based metrics. The remainder of the paper is structured as follows: A review of various types of artificial intelligent techniques and their relative merits are presented in Section 2. Section 3 presents a specific survey of areas of application of ANNs in CR and their performance metrics based approach. Conclusion and recommendation are presented in section 4 which concludes the paper.

AI Techniques Used in CR Implementation

A general review of different types of AI applicable to CR implementation is presented in this section. Furthermore, the benefits and drawbacks of each approach are also highlighted.

Genetic Algorithm (GA): GA is a kind of evolutionary algorithm (EA) used in CR, which is founded on the bases of biological evolution process. It uses natural evolution process to mimic nature in the search of optimal solution for a specific problem (Chen & Yu, 2005; Ding, Xu, Su, & Zhu, 2010). Chromosome and fitness functions definitions are essential to the description of GA (Ding, et al., 2010). An abstract representation of candidate solutions is referred to as Chromosomes. The desirability of a solution is quantified by the fitness function, which is closely correlated with the objective of the algorithm or optimization process. Candidate solutions are evaluated on the basis of the fitness levels, that is, the values they generate for the fitness function, which characterize the performance of candidate solutions (He, et al., 2010).

The GA uses a probabilistic rule to guide its search thereby reducing the risk of convergence to local minima and exploring the most promising areas in search space. This is achieved by considering many points in the search space simultaneously and favouring the mating of the fitter individuals. GA is an effective and robust search algorithm that allows the quick location of high quality solution areas in a large and complex search space (Chen & Yu, 2005; Ding, et al., 2010; Ding, et al., 2011; He, et al., 2010). GA stands out among other search algorithms and distinguishes itself by working on a population of individuals, each representing a possible solution to the problem (Ding, et al., 2011). The fundamental principle of GA includes fitness function evaluation, population solution encoding and decoding, selection, reproduction and convergence (Ding, et al., 2010; He, et al., 2010).

Areas of Practical Application to CR: There are various areas of application of GA to CR. This includes its utilization in the intelligent control of software defined radios (Rondeau, Le, Rieser, & Bostian, 2004), its adoption to solve multi-objective optimization problems and to dynamically configure the CR in response to the changing wireless environment (Ding, et al., 2011; He, et al., 2010), and its utilization in optimizing CR for autonomous vehicle communication (Hauris, 2007).

Artificial Neural Network (ANN): Biological neurons constitute the basic component on which the biological neural network is made up. They are physically connected or functionally-related in the human nervous system specifically in the human brain. In contrast, ANNs are made up of artificial neurons interconnected with each other to form a programming structure that mimics the behavior and neural processing of biological neurons (Katidiotis, et al., 2010).

ANN is basically a set of nonlinear functions with adjustable parameters to give a desirable output (Aibinu, Salami, & Shafie, 2012; Aibinu, Shafie, & Salami, 2012; He, et al., 2010). Classification of ANNs can be done through their training methods and network configurations, which facilitate a multitude of applications. A concise detail of those peculiar to CR are highlighted:

(i) *A multilayer nonlinear perceptron networks (NPNs):* The NPNs enable the incorporation of non-linearity in the network and provide a highly flexible and dynamic results. The use of back propagation for training results in increase in processing time needed to achieve a precise result. Consequently, it is slow to converge during training(He, et al., 2010).

(ii) *A radial basis function networks (RBFNs):* The RBFN has a built-in distance criterion with respect to a center in its hidden layer. This prevents the network from settling into local minimal which is a challenge peculiar to perceptron networks (He, et al., 2010).

(iii) *A multi-layer linear perceptron networks (MLPNs):* This network is made up of layers of neurons where each neuron is a linear combination of the previous output (A. Aibinu, Salami, & Shafie, 2010; A. M. Aibinu, Salami, & Shafie, 2011; He, et al., 2010). The size of the network and application determine the performance of the training algorithms.

Types of Neurons used in ANN

ANN is made up of a collection of simple processing units called neurons. Basically they are three distinguishable types of neurons within the ANN namely, (1) the input neurons, which are the neurons that is responsible with receiving data from outside the neural network and is organized in a layer known as the input layer. (2) the output neurons, which are the neurons that shoulder the responsibility of sending data out of the neural network, and is generally made up of the output layer, and (3) the hidden neurons whose input and output signals remain within the neural network and form the so called hidden layer (Katidiotis, et al., 2010).

Neuron communicates with each other by sending signals over a large number of weighted connections (Katidiotis, et al., 2010). These resulted to a network with high degree of interconnection. Generally, a *weight* w_{jk} is used to define each connection. This weight determines the effect that the signal of neuron *j* has on neuron *k.* Each neuron has an activation state Y_k, which could be the equivalent output of the neuron. Each neuron *k* receives input S_K from two possible sources viz (1) neighbors belonging to different layers and (2) external source referred to as bias offset b_k , and uses them to compute an updated level of activation Y_k as illustrated in Fig.1. This is achieved through the utilization of an activation function F_k as expressed in equation (1).

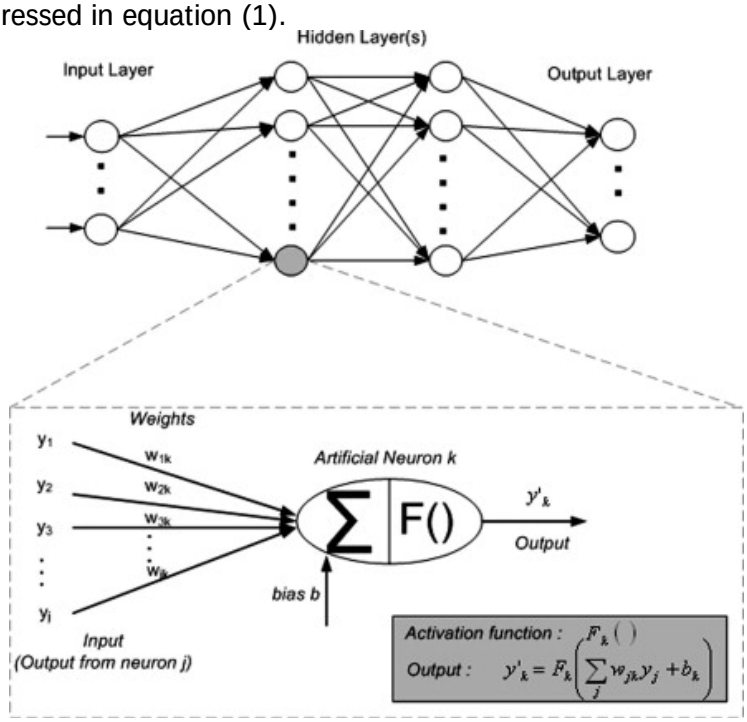

Figure 1: A Typical Neural Network

$F_k = [\sum_j w_{jk} y_j + b_k]$ (1)

There are several types of activation function used in ANN, this includes threshold, signum, ramp, step, unipolar sigmoid and bipolar sigmoid function (Ding, et al., 2010; Ding, et al., 2011; Katidiotis, et al., 2010).

Training of ANN

There are so many algorithms that can be utilized in ANN training. However the most common and presumed effective algorithm is the backpropagation algorithm, which will be discuss in this paper.

(i) *Backpropagation Algorithm (BP)*

The BP is the most common type of algorithm utilized for the training of ANN. It is a supervised learning algorithm that uses a batch mode or sequential method to train a multilayered perceptrons or feedforward neural network (Ding, et al., 2011; Katidiotis, et al., 2010). In a multilayered structure, the backward propagation of an error signal through the network is achieved using gradient search technique. The changing of the synaptic weights connected to the neurons in the hidden and the output layer is achieved by the back propagation of errors through the network (Ding, et al., 2011; Katidiotis, et al., 2010). The BP is a generalization of the delta rule that is utilized for training multi-layer feed-forward neural networks with non-linear units. Basically, it is a gradient descent method designed to minimize the mean error or total error of the output computed by the network. The architecture of BP neural network is illustrated in Fig. 2.

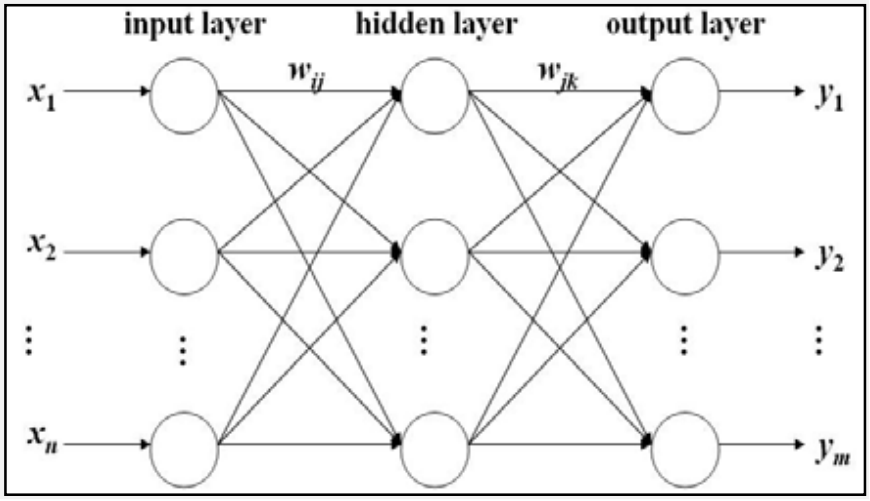

Fig. 2: Architecture of BP Neural Network (Ding, Xu, Zhu, Wang, & Jin, 2011)

Assuming, there are *n* inputs layers, *m* output layer and *s* neurons in the hidden layer of the network. The output of the hidden layer b_j and that of *jth* neuron in the hidden layer can be obtained using equation (2) and (3) below

$b_j = f_1(\sum_{i=1}^{n} w_{ij} x_i + \theta_j)$ (2)

Where,

(i = 1, 2, - - -, n; j = 1, 2, - - -, s), θ_j is the assumed hidden layer threshold, wi_j is the weight from input layer to the hidden layer and f_1 is the hidden layer transfer function.

The output y_k is obtained as shown in equation (3)

$y_k = f_2(\sum_{j=1}^{s} w_{jk} b_j + \theta_k)$ (3)

Where,
(j = 1, 2, - - -, s; k = 1, 2, - - -, m), θ_k is the output layer threshold, w_{jk} is the weight from the hidden layer to the output layer and f_2 is the output layer transfer function.
The error function (e) is defined as the difference between desired output and network actual output and is expressed as

$$e = \sum_{k=1}^{m}(t_k - y_k)^2 \quad (4)$$

Where,
t_k is the desired output and y_k is the output of the network
The continuous process of readjusting the weight and the threshold value is used for the network training. These readjustments is done in order to minimize the network error to a pre set minimum or stop at a pre set training step. The forecasting result is then obtained by inputting forecasting samples to the trained network.

Areas of Application of ANN in CR

There are numerous areas of application of ANN in CR which includes its utilization in signal classification by utilizing the extracted cyclostationary signal features (Fehske, Gaeddert, & Reed, 2005), its application in spectrum sensing (Qi, Zhihui, & Keqin, 2012). The ANN is also used for radio parameter adaptation in CR with threetypes of optimization namely, (1) minimizing the transmit power, (2) meeting the BER and (3) maximizing the throughput [11]. Furthermore, the ANN is used for pattern classification in a pattern-based transmission for CR [5] and in characterizing real time achievable communication performance in CR as proposed by Baldo and Zorzi (Baldo & Zorzi, 2008). A detailed discussion of several areas of applications of ANN is presented in section 3.

Hidden Markov Model (HMM)

The hidden markov model was developed to analyze and describe a complex random phenomenal behavior that can be modeled as a markov process with observable and unobservable states. This model is a convenient and mathematically tractable statistical model (He, et al., 2010). This technique has the capability of prediction based on experience. Also, it is easily scalable, excellent for classification and can be used to model complex statistical processes. However, it requires a good training sequence and it is computationally complex.

Areas of Application in CR

The hidden markov model has several areas of application in CR. This includes its utilization in processing signal cyclostationary features for primary signal detection (Kim, Akbar, Bae, Um, Spooner, & Reed, 2007). It can also be used for spectrum sensing as demonstrated in (Akbar & Tranter, 2007). An HMM-based dynamic spectrum access algorithm was used in predicting the spectrum occupancy of the licensed radio bands for CR networks.

Metaheuristic Algorithms

A metaheuristic algorithm is used in CR to search through a solution space while learning and establishing the requisite relationships in computationally hard problems (He, et al., 2010). The technique is good in optimizing parameters and other learning techniques can be used in the training phase. However, the formulation of rule space is difficult if optimization or learning is not restricted. There are various types of metaheuristic algorithms as highlighted below.

(i) *Tabu search:* This technique can be easily implemented, the performance of the search method is enhanced by using a memory structure called tabu list, which ensures that a

recent move is not repeated or reversed (He, et al., 2010). Its efficiency is determined by an appropriate parameter selection.

(ii) *Simulated Annealing:* The simulated annealing is a simple approach for global optimization in a large search space. It is easy to implement however, it has a slow convergence rate (He, et al., 2010).

(iii) *Ant colony optimization (ACO):* The ACO mimics ant behavior by walking around a graph representing the problem to be solved and finding locally productive areas (Dorigo & Blum, 2005). It is easy to adapt to real time change however, it is not efficient for local searches.

Areas of Applications in CR

There are various areas of application of metaheuristic algorithm to CR. These include its utilization in the dynamic configuration of the CR in response to the changing wireless environment (He, et al., 2010) and in the adaptation of the radio parameters of a software defined radio to the changing radio environment.

Areas of Application of ANN in CR

A survey of various areas of application of ANN in CR is presented in this section. Furthermore, a general performance metrics for different areas are also examined.

Survey of Areas of Application of ANN in CR

There are a considerable number of areas where ANN can be applied in the design of CR. For instance, in (Baldo & Zorzi, 2008), Baldo and Zorzi proposed multilayered feed forward neural networks as an effective technique for real-time characterization of communications performance. This provided a general-purpose black box modeling (it consists of analyzing input-output relations of the system under consideration, and trying to build a predictor with the purpose of estimating output values for unknown combinations of the inputs) of the performance as a function of the measurements collected by the CR device, thus providing good modeling accuracy. Also, it is flexible and as such can be used for runtime modeling in different applications and scenarios and no prior knowledge of the laws driving the real system is required. Furthermore, it avoids all assumptions which are not verifiable in practice and has the ability to account for non-idealities in parameters i.e. tolerance of components, device failures, etc. However, a great challenge is how to effectively determine the values of the weights and biases that will provide the desired approximation for arbitrary continuous functions defined over compact subsets during training. Also, an additional effort and time is needed in training the multilayered feed forward neural network (MFNN) when adding a new variable to an MFNN performance predictor.

A technique that can be used in adjusting radio parameter was presented in (Rondeau, et al., 2004). In this work, an adaptation mechanism that uses GA to optimize the radio parameters on the physical layer was proposed. The GA is used to realize cross layer optimization and a method of adaptive waveform control (He, et al., 2010; Rondeau, et al., 2004). It is referred to as the Wireless System Genetic Algorithm (WSGA) (Rondeau, et al., 2004). The adaptive component that uses the GAs leads to the development of a radio defined by a chromosome. The chromosome's genes represent the adjustable parameters in a given radio and by genetically manipulating the chromosome; the GA can find a set of parameters that optimize the radio for the user's current needs. In the WSGA, the radio behaviour is interpreted as a set of physical and MAC layer operation parameters defined by traits encapsulated in the genes of a

chromosome (Rondeau, et al., 2004). Power, frequency, pulse shape, symbol rate and modulation are used to represent chromosome for GA manipulation and are also identified as possible genes in the chromosome definition to allow for future growth through each layer of the radio communication's stack.

The advantage of this technique is that it has a dynamic fitness definition and evaluation where the weighting of each function is adaptive. Also, it has the capability of enabling any fitness function to be used as required by the current link conditions and user requirements. Furthermore, it has the capability of applying constraints to the optimization problem, which facilitated the incorporation of regulatory and physical restrictions during chromosome evolution, and the WSGA is capable of working with real hardware to accomplish real goals. However, the use of proxim tsunami radios, which has a limited number of adaptable parameter for experiment is a demerit. In addition to this, the convergence speed of the system is slow and there is no assurance that the winning member, after all the single comparisons in all dimensions is the best or non dominated member of the population.

Tsagkaris *et al.* focused on the channel estimation and predictive modeling phases where a benchmarking work that aims at evaluating the applicability of multiple types of NNs in the learning module of the cognitive engine (CE) within a cognitive terminal is developed (Tsagkaris, Katidiotis, & Demestichas, 2008). The proposed ANN-based learning schemes relax the reasoning process and assist in the optimum decision regarding the radio-configuration settings (mainly PHY and MAC layers) that provide the best QoS for the given problem and user application needs. A potential solution is proposed that assists the CRs in the derivation and enforcement of decisions regarding the selection of desired radio configuration which will optimize its QoS. ANN was used as the proposed solution, which was motivated by the fact that the NNs have the ability to learn from given examples. Two NN-based learning schemes were set up and tested namely, the 'basic' and the 'extended' one. While the former one aims at building the framework for developing such learning schemes and applying them into future CR based systems, the latter one stresses that such a learning scheme should be extensible, i.e., flexible in incorporating further information data in the learning process (Tsagkaris, et al., 2008).

In the basic NN-based learning scheme, an Elman network is the NN that was selected for the basic scheme which, is a two-layer back-propagation, recurrent network, with the addition of a feedback connection from the output of the unique hidden layer to the input layer (Tsagkaris, et al., 2008). This recurrent connection allows the Elman network to both detect and generate time-varying patterns. The NN uses the Tansig function shown in equation (5) for the neurons in its hidden (recurrent) layer, and the Logsig function in equation (6) for the neuron in its output layer respectively.

$$\square_{\square}(\square_{\square}) = \frac{1}{1+\square^{-\square_{\square}}} \quad (5)$$

$$\square_{\square}(\square_{\square}) = \frac{2}{1+\square^{(-2\square_{\square})}} - 1 \quad (6)$$

where S_K = input neurons from neighbors belonging to different layers and F_K = Activation function. A delay line of five slots was inserted in the input layer, which corresponds to the time window which are slots that was used to represent past experience and knowledge collected by the NN.

The proposed approach has the ability to learn from given example and hence perform better in cognitive tasks. Furthermore, it has a good data rate prediction capability. However, the assumption that the NN-based scheme should be tuned in an arbitrary radio configuration is a drawback of the technique. Also, there may be overtraining or over fitting of the training data as a result of the network not being properly trained, which may lead to the network not learning the basic structure of the data but instead learning irrelevant details of the individual cases. In addition to this, a realistic input time series and environment situations are not considered; this may affect the NN-based schemes validity and robustness.

Feng *et al*. proposed a statistical mean throughput as evaluation criteria for cognitive user with fixed rate service in spectrum sensing (Qi, et al., 2012). It was assumed that the state of vacancy and occupancy time of objective license channel are independent of each other with exponential distribution. Furthermore, it was also reported that N objective license channels is being predicted based on the result of machine learning at each time slot. The cognitive user with fixed rate service based on machine learning spectrum sensing has better performance compared to random spectrum sensing. Also, there is decrease in the packet loss rate as the channel time detection threshold increases. However, there is decrease in effective transmission time and difficulty is encountered in determining an appropriate method of increasing the sample size for the statistical mean throughput since it is impossible that the sample size tends to infinity.

In (Fehske, et al., 2005), ANN-based signal classifier was developed. It utilizes the extracted cyclostationary signal features, a new method for classification of communication signals based on cyclic spectral analysis and pattern recognition performed by a neural network was proposed (Fehske, et al., 2005). Two cases were studied: Classification with and without prior knowledge of carrier and bandwidth of the signal. Distinct features of each signal type were extracted using cyclic spectral analysis, and a neural network was designed to classify signals based on these features. The combination of the cyclostationary analysis and ANN provides an efficient and reliable signal classification. A multilayer linear perceptron network (MLPNs) with 4 neurons in the hidden layer was used for each signal class during training. Each MLPN was trained with a back propagation algorithm.

The strength of the approach was in the reduction of the online processing time. Also, it provides an efficient and reliable signal classification and is robust to stationary noise. However, difficulty is encountered in comparison due to the practical limitations of the number of modulation type analyzed. Furthermore, a scenario where there are two or more signals such as BPSK, QPSK, FSK etc being present at a time was not considered.

A Concise Details of CR Performance Metrics

The most essential and challenging steps in the successful CR design by researchers is usually in establishing and choosing the effective performance metrics (Zhao, Mao, Neel, & Reed, 2009). It is consensus that the formalization of CR benchmarking methods and performance metrics would assist in hastening the integration of CR paradigm into existing wireless networks (Zhao, et al., 2009).

A quite reasonable numbers of metrics can be defined and has been utilized to evaluate CR performance since CR can support numerous various applications. Despite the great number of choices that are available, there is still need for careful selection of performance metrics as the

selection will impact many aspects of CR design. The Cognitive Engine (CE) needs to adopt dynamic situation-aware utility functions, in order to be responsive to changing radio scenarios and the tradeoffs among various (possibly conflicting) objectives, rather than relying on a single static function.

Generally, CR node can be evaluated based on four areas namely, the cognitive functionality, the overall node performance, complexity, and technical maturity. Some performance metrics that can be used in the CE to drive the operation of CR are highlighted in Table 1 for easy and quick comparisons.

Table 1: Summary of Performance Metrics of ANN in CR

Paper	Input Parameters	Output Parameters	Usage	Environmental and other factors considered	Activation Function	Layers	Performance Metrics
(Qi, et al., 2012)	Alternate time of channel vacancy/ occupancy state	Throughput, Packet loss rate	Spectrum Sensing	Number of detected transmission	Threshold Function	Statistical mean throughput	Throughput, Packet Loss rate
(Fehske, et al., 2005)	Carrier Frequency, Symbol Rate, SNR	Spectral coherence function, Reliability	Signal Classification	The signal's carrier and bandwidth is known. It was assumed that there is no prior knowledge of the signal other than its presence	Linear Function	Multi-layer linear perceptron network	Spectral coherence function of each of the signal type i.e., BPSK, QPSK, FSK and MSK Probability of classification for varying SNR, Probability distribution for confidence levels
(Rondeau, et al., 2004)	BER, Frequency, Power	Spectral Occupancy, Throughput, Interference	Radio Parameter Adaptation	Incorporation of regulatory and physical restrictions during chromosome evolution	It utilizes the dynamic fitness definition and evaluation where the weight of each function is adjustable and any fitness function	Multi objective genetic algorithm	Interference avoidance, Throughput, Spectral Occupancy

					may or may not be used depending on the current link condition and user requirement		
(Baldo & Zorzi, 2008)	SNR, Received Frames, Erroneous Frames, Idle Time	Throughput, Delay, Reliability	Performance characterization of the components of a cognitive radio system	Number of detected transmissions/ Number of users	A Sigmoid Function	Multi layer feed forward neural networks	Throughput
(Tsagkari, et al., 2008)	Time series collected by the radio-scene analysis phase	Mean squared error	Channel estimation and predictive modeling phases	Estimation of time zone parameter	Sigmoid Function	Multilayer linear perception	Mean squared error

Conclusion and Reccomendation

This paper reviewed different types of AI techniques namely GA, ANN, Metaheuristic Algorithm and Hidden Markov Models that have been proposed in literature to provide the cognition capability in a CE. It was shown that the AI technique is the pivot for numerous CR applications such as its utilization in spectrum sensing, radio parameter adaptation and signal or pattern classification. The understanding of the tradeoffs in the selection and design of AI processes is crucial in the successful design in CR. The AI techniques have been utilized in many CR applications as expounded in the paper. However, numerous implementations are still rudimental probably due to the interdisciplinary nature of the field. Furthermore, there is need to pay more attention to the CE training process, which is crucial to its performance. The use of cooperative sensing can fasten training. However, in order to limit potential security vulnerabilities, there is need for the authentication of the sources and the externally learned behavior should be evaluated against self generated field measurements. Also, in order to maximize the payoff of CR there is need to design a CR that will support self organizing network that can improve the continuous management of heterogeneous network elements and radio resources far beyond what the CR designers could conceive.

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SURVEY OF INTRINSIC/EXTRINSIC MOTIVATION, JOB SATISFACTION AND JOB PERFORMANCE IN UNIVERSITY LIBRARIES IN NORTH-CENTRAL, NIGERIA

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Abstract

The study investigated the relationships among intrinsic, extrinsic motivation, job satisfaction and job performance in University Libraries in North-Central Nigeria. The objectives of the study are to find the strength of the relationships among intrinsic / extrinsic motivation, job satisfaction and job performance as well as determining the contribution of intrinsic, extrinsic motivation and job satisfaction to job performance in University libraries in Nigeria. Null hypotheses formulated include: there is no significant relationships among intrinsic / extrinsic motivation and job satisfaction to job performance. There is no significant contribution of intrinsic / extrinsic motivation and job satisfaction to job performance. The target population of the study consisted of professional and para-professional staff in functional University libraries in North-Central Nigeria. The entire population of professional and para-professional staff in the functional university libraries in the zone was adopted. The modified instrument tagged: "Intrinsic, Extrinsic Motivation Job Satisfaction, Job Performance Questionnaire" (IEMJSJPQ) was administered on the two categories of staff in University libraries in the zone. A Statistical Package for Social Science version 17 was used to conduct the statistical analysis. The critical value of 0.125 was used as basis to test the null hypotheses. Multiple correlation coefficient and regression models were the statistical tools used to test and analyzed the formulated null hypotheses. The findings showed weak relationships among intrinsic, extrinsic motivation and job satisfaction but strong relationships existed between extrinsic motivation and job performance. There was no significant contribution among intrinsic, extrinsic motivation and job satisfaction to job performance of library staff in functional university libraries in North-Central Zone of Nigeria. The study recommends that the management of the universities in the zone should emphasize on intrinsic motivation such as work itself, recognition and opportunities for achievement so that library personnel can make positive contribution to university libraries.

Keywords: Intrinsic/Extrinsic Motivation; Job Satisfaction; Job Professional and Performance; Universities Libraries; North-Central Nigeria.

Introduction

An organization or institution usually consists of group of people working together for the attainment of set objectives. This translates to mean that in every organization or institution, there are stated objectives to be achieved. The stated objectives could adequately be achieved when human and material resources of such an organization or institution are properly managed.

Motivation as a concept, is concerned with the aspect of human life that energies, propels and stimulates human beings to change behaviour for the attainment of an organization's goals/objectives, thereby achieving higher productivity. According to Etubi and Ikekhai (2007),

motivation is regarded as the use of incentives to person from whom activity is needed or required. They further postulate various approaches adopted to motivate staff to perform efficient job during the retrospective conversion exercise. These approaches include creation of adequate awareness on the benefits of the project to staff participating in the exercise as well as community. Other approaches include use of financial incentives, creation and maintenance of a conducive atmosphere for the project team.

Motivation could be intrinsic and extrinsic. The intrinsic motivation is the behaviour exhibited from the performance of job e.g. work itself, recognition, achievement, etc. The extrinsic motivation is the behaviour a worker exhibits so as to get reward. It is the offering of reward to a subordinate by supervisor or manager e.g. pay, promotion, working conditions (Akanbi, 2011). In a study of the relationship between rewards and employees' performance in the non-profit organizations in Pakistan, Hafiza, Shah, Jamsheed and Zaman (2011) classified motivational factors into two areas: intrinsic rewards and extrinsic rewards. The intrinsic rewards include empowerment and autonomy, recognition and appreciation and challenging tasks. The extrinsic rewards include pay, bonuses, fringe benefits and promotions.

Library as one of the recognized institutions in the society is not left out in the need to motivate staff through recognition, praises, prompt payment of salaries, increase in workers' salaries, staff training, participatory management, effective communication and free flow of information. Management of library as well as library administrators can motivate workers to perform efficient job by making library work more challenging and interesting as well as appreciating their good performance; promotion, taking care of their welfare, staff development and participatory management (Ugwuanyi, 2011).

Since motivation is aimed at a positive change in behavioural pattern of workers' performance, there is the need for a worker to give his/her personal assessment on the extent of motivation received or enjoyed based on job performance, which is usually a function of job satisfaction. Job satisfaction therefore, is workers' perception, assessment or attitude towards their job based on the degree/extent of motivation received, and thus job satisfaction is the direct product of motivation (Boluade, 2004). A low or high level of job satisfaction is a function of the extent of motivation derived by workers; thus a hard-working staff that received low level of satisfaction or dissatisfaction would develop negative attitude towards not only the job but also towards the boss or fellow workers (Bamigboye, Buraimo and Ajani, 2006; Tella, Ayeni and Popoola, 2007). Job satisfaction is linked with motivation and thus satisfaction leads to performance.

Villamova, Austin and Borman (2005) cited Austin *et al* (1991) to have described job performance "as that aspect of work behaviour domain that is of relevance to job and the organization's objectives". Job performance varies from organizations to organizations. For example, jobs performed in bank include: receiving and payment of cash to customers, balancing of accounts, management of bank records, etc. Jobs performed in library include cataloging and classification of materials, provision of reference services, charging and discharging of library materials to users, etc.

Job responsibilities of personnel in an academic library as per professional staff include book selection, ordering and acquisition of library materials, provision of reference and circulation services, library instructions as well as cataloging and classification of library materials. The

para-professional staff job responsibilities include filing cards into catalogue cabinets, writing and checking orders; providing assistance to readers in the location of books; stock editing, etc (Maduekwe & Ajale, 2000). Job performance in a library is not only geared towards meeting users' information needs but also serve as criteria for promotion.

From researcher's observation, it was discovered that library personnel performance was low and this could be attributed to inadequate motivation as personnel feel not satisfied with the job. However, this study seeks to find out the relationships among motivational factors, job satisfaction and job performance among professionals and para-professionals in university libraries within the North-Central, Nigeria.

Statement of the Problem

University libraries are established to support learning, teaching, research and service to community. University library personnel (professionals and para-professionals) are expected to perform the statutory functions so as to achieve the set objectives of their university library. These functions include selection and acquisition, processing, organization, cataloguing and classification, provision of reference services, bibliographic services, computerization of library services, etc. For these services/functions to be effectively performed by professional and para-professional staff, they need to be adequately motivated. University Management needs to adequately motivate library personnel by way of making job interesting, recognize and praise staff for good work; provide financial incentives, training, good leadership styles, free flow of information communicated among personnel, etc. Motivation encourages performance which in turn leads to job satisfaction and consequently stimulates high performance and productivity. Where motivation is lacking, staff will end up not performing their job well (Boluade, 2004), as research findings have shown inconsistencies in the relationships or otherwise among motivation, job satisfaction and job performance of workers. In order to ascertain the inconsistencies in the research findings, it is necessary to empirically investigate the relationships among intrinsic / extrinsic motivation, job satisfaction and job performance of library personnel in universities in North-Central, Nigeria.

Objectives of the Study

The main objective of the study is to determine the strength of relationship and contribution of intrinsic/extrinsic motivation, job satisfaction and job performance of professional and paraprofessionals in university libraries in North-Central, Nigeria. The specific objectives of this study are to determine the:

(i) Relationships among intrinsic/extrinsic motivation, job satisfaction and job performance of library personnel in university in North-Central, Nigeria;

(ii) Significant contribution of intrinsic / extrinsic motivation and job satisfaction to job performance of library personnel in university in North-Central, Nigeria.

Research Questions

The following questions were raised to provide answer to the study:-

(i) What are the degree of relationships among intrinsic/extrinsic motivation, job satisfaction and job performance of library personnel in university libraries?

(ii) What are the extent of contribution of intrinsic / extrinsic motivation and job satisfaction to job performance of library personnel?

Hypotheses

The following null-hypotheses were formulated and tested at 0.05 level of significance:-

Ho_1: There are no significant relationships among intrinsic, extrinsic motivation, job satisfaction and job performance of library personnel,

Ho_2: There is no significant contribution of intrinsic, extrinsic motivation, job satisfaction to job performance of library personnel.

Literature Review

Akanbi (2011) investigated the influence of extrinsic and intrinsic motivation on job performance of 100 workers of flour mills, Lagos using questionnaire. Two hypotheses (of significant relationship between extrinsic/extrinsic motivation and job performance) were tested using PPMC at 0.05 level of significance. The study found a positive relationship between extrinsic motivation and job performance, though there was no relationship between intrinsic motivation and job performance. This means that when there is an increase or decrease in salary, allowances, etc of workers, there will be an increase or decrease in workers' performance respectively.

Natolooka and Otengo (2011) investigated the cause of labour turnover in relation to job satisfaction and the negative/positive effects on employees' performance in local governments in Uganda. The case study was used to examine seven rural sub-counties and four urban divisions. Two methods (questionnaire and in-depth interviews) were used for data collection. Data were analysed using frequencies, tables and percentages. The results of the study showed that:- there was poor working conditions (which are characterized) by poor/low salary, accommodation, facilities, recreational and social amenities and welfare facilities. It also revealed that there exist inadequate opportunities for promotion and training; job insecurity; poor job design; stressful work environment and poor management style. This situation has had both negative and positive effect on employees' performance; many employees were de-motivated and lack job satisfaction as well as commitment which led to less productivity. The effects were the promotion of internal staff and employing new innovative staff.

A collaborative research work was conducted by Zakaria, Hussain, Noordin, Sawal and Zakaria (2011) on the relationship between reward practice and employees' performance. The population consist Toyota 35 centre, SP Salaton and Otomobial Sdn Kedah. The study adopted non – probability convenience sampling and 82 copies of questionnaire were distributed to employees on their perception of the reward practice related to organizational performance. The collected data were analyzed using the SPSS version 16.0 through descriptive data and correlation. Pearson correlation was used to test the hypotheses. The findings showed that there was no significant relationship between employees' perception on transparency of reward practice and employees' performance. All factors were not significant to contribute to employees' performance.

Olusola (2011) investigated intrinsic motivation, job satisfaction and self-efficacy as predictors of job performance of 1100 industrial workers in Ijebu zone of Ogun State, Nigeria. The aim of the study was to examine the contribution of self-efficacy, intrinsic motivation and job performance. Simple random sampling technique was used to select 300 workers from the two industries. Four instruments: Intrinsic Motivation Inventory (IMT), Self-Efficiency Scale (SES) and Annual Performance Evaluation Form (APER). Multiple regression analysis was used to test the hypotheses at 0.05 level of significance. The results showed that self-efficacy, intrinsic

motivation and job satisfaction collectively and individually will predict the job performance of industrial workers.

As part of the investigation conducted by Olorunsola (2010), personal/ demographic characteristics were also examined. The results of the investigation on the personal characteristics of administrative staff in the government-owned universities of South West, Nigeria revealed the following. There was no significant difference in the working experience of male and female administrative staff. On the other hand, age and gender significantly influence job satisfaction. Personal working experience and type of university influence job performance of administrative staff.

Saka and Haruna (2013) examined the relationship between staff development and job performance of personnel in branch libraries of University of Maiduguri. The study adopted the entire population of 47 personnel in all the 15 branch libraries. Pearson Product Moment Correlation and regression model were statistical tools used to test the four null-hypotheses. The study found no significant relationship between formal education and job performance. Significant relationship existed between seminars/conferences and job performance as well as workshop attendance and job performance. The study further revealed high strength of relationship among formal education, seminars/conferences, workshop attendance and job performance with R-value of 60%.

In a situation where poor performance is noticed from employees or an employee's performance is below expectation, it would be assumed that the management is unable to recruit qualified staff, provide working materials and above all handle staff welfare properly, etc (Boluade, 2004). The manager or the immediate supervisor needs to evaluate/appraise subordinates' performance on regular basis so as to determine pay and promotional decision, develop plan for correcting any deficiency and review employee's career plan (Dessler, 2011).

Methodology

Survey method was used for the study because data were collected so as to describe and interpret the existing relationships among motivational factors, job satisfaction and job performance of professional and para-professional library personnel in universities in North-Central, Nigeria. Survey research was used because of the large area covered. Data were collected from the entire population of professional and para-professional library staff in all the surveyed universities in North-Central, Nigeria.

The target population of the study comprised 301 professional and para-professional library personnel (160 professionals and 141para-professionals) spread across the 17 fully operational universities in North-Central, Nigeria. The fully-operational universities within the context of this study are the established universities that have library personnel on ground for not less than one year as at March, 2012. The population distribution cuts across both government and privately-owned universities in the North-Central, Nigeria. See appendix at the last page.

The entire population of 301 library personnel in all the functional university libraries in North-central, Nigeria as at March 2012 was adopted for the study and so there was no sampling. The modified instruments tagged Intrinsic Extrinsic Motivation and Job Satisfaction, Job Performance Questionnaire (IEMJSJPQ) was designed into two sets comprises four likert scales (Strongly Agree - 4, Agree - 3, Disagree - 2, Strongly Disagree - 1). The copies of questionnaire were

administered on the entire population of professional and para-professional staff in all the functional university libraries in North-Central geo-political zone of Nigeria. Parts of Olorunsola (2010) questionnaire on job performance were adopted for the study. Influential statistical tools such as Multiple Correlation Coefficient and Regression Models were used to test the null hypotheses of the strength of the relationships as well as the contribution of intrinsic / extrinsic motivation and job satisfaction to job performance of library personnel respectively. Statistical Package for Social Science (SPSS) version 17 was used to conduct the statistical analysis of data. The critical value of 0.125 was used as a standard for testing the two null hypotheses.

Results

Out of 301 copies of questionnaire administered, 256 (85%) were filled, returned and found usable.

Table 2: Respondents by gender

Gender	Frequency	Percentage (%)
Male	149	58
Female	107	42
Total	256	100

Out of 256 respondents, 149 (58%) were males while 107 (42%) were females. This would imply that male and female personnel in the university libraries could be said to be fairly represented in the study which thus balanced up the gender consideration.

Testing of hypotheses

Hypothesis 1: There are no significant relationships among intrinsic, extrinsic motivation, job satisfaction and job performance of library personnel in universities in North-Central, Nigeria.

The sub-aggregate of motivational factors for intrinsic and extrinsic motivation along with the score for job satisfaction and job performance were correlated with the aid of the Pearson product moment correlation coefficient for the test of this hypothesis. The summary of the correlation coefficients between the variables is presented in a square matrix in Table 2.

Table 2: Relationships among intrinsic, extrinsic motivation, job satisfaction and job performance of library personnel in universities in North-Central, Nigeria

Variables	Job satisfaction	Intrinsic motivation	Extrinsic motivation	Job performance
Job satisfaction	1	.515	.508	.105(ns)
Intrinsic motivation	.515	1	.642	.073(ns)
Extrinsic motivation	.508	.642	1	.125(*)
Job performance	.105(ns)	.073(ns)	.125(*)	1
N	256	256	256	256

Key: *: Correlation is significant at the 0.05 level (2-tailed) 0.125
ns: Correlation is not significant at the 0.05 level (2-tailed) 0.073 & 0.105

From the observed multiple correlation in the table 2, job satisfaction is not significantly correlated with job performance of the library personnel. The observed multiple correlation between the two variables (job satisfaction and job performance) was 0.105 compared with the critical value of 0.125 at the 252 degree of freedom. Though job satisfaction was significantly

correlated with intrinsic motivation and extrinsic motivation, the relationship with job performance was not statistically significant. There was no significant relationship between intrinsic motivation and job performance of the library personnel involved in the study. However, the performance of the personnel was significantly correlated with their extrinsic motivation. The observed coefficient of correlation between the two variables is 0.125 and the significance was obtained at the 0.05 level ($P \leq 0.05$). The observed relationship between intrinsic and extrinsic motivation was very high, positive and significant as indicated in the table. The two variables were highly and significantly correlated with the job satisfaction of the personnel. Therefore, on the basis of the relationship among job performance, Job satisfaction, intrinsic motivation, there was enough evidence to accept the null-hypothesis but on the basis of the interrelationship of the other variables, the null- hypothesis was rejected.

Hypothesis 2: There is no significant contribution of intrinsic, extrinsic motivation and job satisfaction to job performance of library personnel

The linear regression procedure was used with least square method. Performance of the library personnel was used as the dependent variables while the sub-aggregate of motivational factors (intrinsic, extrinsic motivation) and job satisfaction were used as the independent variables. The use of the regression model for the test was to establish the functional relationship or the contribution of the independent variables to the job performance of library personnel in universities in North-Central, Nigeria.

Table 3: Regression estimates of the contribution of intrinsic, extrinsic motivation and job satisfaction to job performance of library personnel in north-central, Nigeria

Variables	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	2.262608	0.228837		11.47576	8.74E-25
Job satisfaction	0.064394	0.075078	0.064959	0.857695	0.391879
Intrinsic motivation	-0.03653	0.09525	-0.03268	-0.38348	0.701689
Extrinsic motivation	0.109057	0.082663	0.112	1.319293	0.188273
Dependent Variable: Job performance					

From the observed significant levels for the contribution of each of the variables shown on the table, the selected parameters could not be said to be significant determinant of the personnel's performance of their respective jobs in the surveyed university libraries. The functional relationship between the dependent variable (job performance) and the independent variables (intrinsic, extrinsic motivation and job satisfaction) could be expressed as $Y= a + bx1 + bx2 + bx3$, where b represents the estimated coefficient and x for the independent variables. With the model, the functional relationship between the variables could be expressed as job performance =2.262+0.064394, job satisfaction-0.03653 intrinsic motivation + 0.109057 extrinsic motivation. But the observation here did not reveal that any of the independent variables could be said to be a significant determinant of job performance by the personnel. There is adequate evidence to accept the null hypothesis. This is because the contribution of the independent variable could not be said to be significant factors of the personnel's job performance in the selected libraries of the North-Central, Nigeria.

Discussion of Findings

Multiple correlation was used to test the first hypothesis which states that "there is no significant relationship among intrinsic, extrinsic motivation, job satisfaction and job performance of library personnel". The result revealed that job satisfaction and intrinsic motivation were not significantly correlated with the job performance of library personnel. The extrinsic motivation which comprises of staff development, financial incentives, communication and participatory management were the components found to be significantly correlated with the job performance of the library personnel.

The findings of hypothesis one, corroborates Akanbi (2011) and Saka and Haruna (2013). Akanbi (2011) surveyed the influence of extrinsic and intrinsic motivation on employees' performance and the result showed positive relationship between extrinsic motivation and job performance. On the other hand, Saka and Haruna (2013) investigated the relationship between staff development and job performance among personnel in branch libraries, University of Maiduguri. The result of the study showed high significant relationship between staff development and job performance of library staff in University of Maiduguri.

Regression model was used to test the second hypothesis on significant contribution of intrinsic, extrinsic motivation and job satisfaction to job performance of the library personnel. Though extrinsic motivation and job satisfaction were found to have positive contribution to the job performance of the personnel but such contribution of these variables were found not to be the major determinants of job performance of personnel in the university libraries. Intrinsic motivation was found to have a negative contribution. However, such contribution was found not to be statistically significant. The null hypothesis was therefore accepted. The result corroborates those of Notolooka and Otenga (2011) as well as Zakaria, Hussaini, Noordim, Sawwal and Zakaria (2011) but disagree with those of Olusola (2011) and Olorunsola (2010). Notolooka and Otenga (2011) found that both inadequate intrinsic/extrinsic motivation, job satisfaction have led to lack of commitment and productivity among employees in a local government area in Uganda. The result reveals inadequate intrinsic/extrinsic motivation which includes job security, job design, opportunities for promotion and training, management styles, salary and communication. Zakaria, Hussain, Noordim, Sawal and Zakaria (2011) reported that all factors were not significant to contribute to employees' performance. In disagreement with the findings of hypothesis two, Olusola (2011) found motivational factors and job satisfaction as important factors in predicting job commitment/involvement of workers in various organizations in Nigeria. Olorunsola (2010) found "achievement" and "leadership quality" as best predictors of job satisfaction and job performance. It should be noted however that "achievement" is an intrinsic motivation while "leadership quality" is an extrinsic motivation; while job satisfaction and self efficacy are regarded as predictors of job performance whether individually or collectively.

Conclusion

Based on the findings, the study concludes that:

(i) Recognition, work itself and achievement were not adequate, hence low job satisfaction and job performance existed. The strength of their relationship tends to be weak. Both intrinsic and extrinsic motivations are moving towards different directions (divergent).

(ii) Inadequate intrinsic/extrinsic motivation, low job satisfaction can neither contribute nor serve as determinants to job performance.

Recommendations

Based on the findings and conclusion drawn, the following practical recommendations are made:

(i) The university administration in North-Central, Nigeria should lay much emphasis on work itself, recognition and opportunities for achievement so that library personnel make positive contribution to job performance

(ii) Management of university libraries in North-Central, Nigeria should provide adequate motivational incentives to enable library personnel develop positive attitude towards work. These can contribute and serve as determinants to job performance. There should be increase in salary, while fringe benefits such as shifting allowance, excess work load, furniture allowances, etc be created. On-the-job training programme such as in-house workshops be organized for junior staff.

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GEOELECTRICAL INVESTIGATION FOR AQUIFER AND GEOTECHNICAL PROPERTIES AT THE PLANNED GIDAN KWANO CAMPUS DEVELOPMENT PHASE II, FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGERIA

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Abstract

The desire of the management of the Federal University of Technology (F.U.T.), Minna, to inaugurate the structural development of Phase II of the Gidan Kwano Campus presented a challenge for the F.U.T. with respect to the creation of a database that the F.U.T. could consult and incorporate into the wider Physical Planning and Development (PPD) scheme. The objective of this study is the creation of a database for aquifer and geotechnical information. Station-separation for the 2km^2 areal extent of the study area was fixed at 200m; thus there are sixty-six principal stations slated for this survey. Because of the need to ensure independent verification of the results being presented, georeferencing of all survey stations for the vertical electrical sounding (VES) investigation was carried out too. However, only sixty-four principal stations were occupied for this exercise because locations of transverse traverse 11-2 and 11-4 (TT11-2 and TT11-4) are coincident with the top of large outcrops. The data collected was processed by means of the windows-compatible WinResist tool to determine the number of layers at each VES station and the Surfer 10 tool to produce the iso-resistivity maps at depths and the map of the thickness regime that is always desired for geotechnical interpretation. As a result of invoking the "Geoexplore Empirical Standardization for Minna Area," the "Olasehinde Protocol," and using the depth map as a strict control the VES locations identified as TT1-3, TT1-4, TT2-4, TT4-1, and TT4-3 are flagged as "strongly aquiferous." The region of all TT9s, TT10s, and TT11s, incidentally closest to the existing Phase I development, especially TT9-3, TT9-4, TT10-3 are most suited for locations that would not prove logistical challenges for site selection for buildings and other structural development. It is recommended that the result of this study be adopted wholeheartedly by the Management of the Federal University of Technology, Minna, as a complementary document for the development of Phase II of the Gidan Kwano Campus.

Keywords: Geoelectrical; aquifer; geotechnical; georeferencing; VES; transverse traverse; iso-resistivity

Introduction

The news that the management of the Federal University of Technology (F.U.T.), Minna, in late 2012, signed a memorandum of understanding (MOU) with a private developer to expand the students' hostel complexes, and the news that the Federal Government of Nigeria would inject sum two hundred and twenty (220) billion naira annually into the Nigeria's university system for wide-ranging infrastructural development as a result of the amicable resolution of the Federal Government (FG) versus Academic Staff Union of Universities (ASUU), FG-ASUU, impasse was a

most welcome development indeed. The study group members immediately recognized challenges in these proposed schemes, and in line with the founding principles of the F.U.T. Minna, a combination groundwater prospect and geotechnical information survey was planned to cover the areal extent of $9^0$30′57.8′′N, $6^0$26′11.4′′E; $9^0$32′02.6′′N, $6^0$26′11.4′′E; $9^0$32′02.6′′N, $6^0$25′39.0′′E; $9^0$30′57.8′′N, $6^0$25′39.0′′E where preliminary civil works suggest that this is the preferred location for the proposed expanded infrastructural development, i.e. Phase II. A successful aquifer-cum-geotechnical survey at this designated area of study would provide a database of groundwater prospects and geotechnical information that the F.U.T. Minna could consult and incorporate into the wider Physical Planning and Development (PPD) scheme. Nowadays, because of the need to ensure independent verification of the results being presented, it is instructive to adopt the practice of georeferencing survey and prospect stations. This practice, in effect, also eliminates the awkward requirement of using wooden pegs to identify survey and prospect locations. In fact, Jonah *et al.* (2014A; 2014B; 2014C; 2014D; 2014E; 2013A; 2013B; 2013C; 2013D; 2013E; 2013F; 2011A; 2011B; 2011C; 2011D) have always argued in favour of georeferencing field dataset and their concomitant tie-in to their specific GIS database.

Surface electrical resistivity surveying is based on the principle that the distribution of electrical potential in the ground around a current-carrying electrode depends on the electrical resistivities and distribution of the surrounding soils and rocks. The usual practice in the field is to apply an electrical direct current (DC) between two electrodes implanted in the ground and to measure the difference of potential between two additional electrodes that do not carry current. Usually, the potential electrodes are in line between the current electrodes, but in principle, they can be located anywhere. The current used is either direct current, commutated direct current (i.e., a square-wave alternating current), or AC of low frequency (typically about 20 Hz). All analyses and interpretation are done on the basis of direct currents. The non-uniqueness or ambiguity of the resistivity method is scarcely less than with the other geophysical methods. For these reasons, it is always advisable to use several complementary geophysical methods in an integrated exploration program rather than relying on a single exploration method (www.epa.gov; Kearey and Brooks, 1988; Parasnis, 1986; Ako and Olorunfemi, 1982; Bonde, 1997; Dangana, 2002; Gana, 1995; Okwueze and Ezeanyi, 1985; Okwueze *et al.*, 1981; Olorunfemi & Fasuyi, 1993; Olorunfemi & Okhue, 1992).

On Aquifer: An aquifer is underground water bearing permeable rock. They acts as reservoirs for groundwater, and sometimes flows out in springs. Aquifers can dry up when people drain them faster than nature can refill them. Sedimentary rock such as sandstone, sand and gravel are examples of water bearing rock. The top of the water level in an aquifer is called the water table. An aquifer fills with water from rain that drains into the ground. In some areas, the water passes through the soil on top of the aquifer; in some others it enter through joints and cracks in rocks. The water moves downward until it meets less permeable rock (www.uwsp.edu).

On the Geotechnical Concept: Geotechnical investigation is usually carried out by professionals that provide information on the physical properties of soil, rocks and rocks types, topography of the selected area as well as using it as a measure of thermal resistivity of soil which is very vital for underground water survey. Geotechnical investigation include surface exploration and sub-surface exploration of the selected site as it provides information regarding elevation, vertical ground movement, map citations, acquisition of geoelectrical data sets through vertical electric sounding process thereby providing a guide for adequate explanation

on the nature of investigation of underground water, problem statement, recommendation as well as references (www. wikipedia.org).

It was observed that, at the moment, there exist no aquifer and geotechnical information in the Federal University of Technology Minna's database for the proposed Phase II of the Gidan Kwano Campus. It is imperative that such subsurface information be available before undertaking any structural development and expansion scheme. In recognition of this stated problem this study was designed with the following critical objectives:

(i) Creation of a database for a 2km^2 area at Phase II for aquifer and geotechnical I nformation;

(ii) Adaptation of the techniques of the fieldwork undertaken here to surveying for possible aquifer prospects at locations that are basically built-up and constricted; this ensures that a particular skill is honed for self-reliance, thus fulfilling the key aspect of the "Student Entrepreneurship Curriculum."

Meeting the stated objectives above would ensure that: Massive cost-saving by the Management of the Federal University of Technology, Minna, with respect to acquiring information for aquifer and geotechnical information at the defined 2km^2 areal extent of Phase II.

The Area of Study

The location most suited for Phase II development at the Gidan Kwano Campus is the 8km^2 areal extent shown in Fig.1, defined to be a perfect rectangle on the ground with its ABCD ends corresponding to the following georeferenced co-ordinates: 09^{0}30′57.8′′N, 006^{0}25′39.0′′E; 09^{0}30′57.8′′N, 006^{0}26′43.8′′E; 09^{0}33′07.4′′N, 006^{0}26′43.8′′E; 09^{0}33′07.4′′N, 006^{0}25′39.0′′E. At a 2km^2 areal extent, the present area of study identified by the following georeferenced co-ordinates: 09^{0}30′57.8′′N, 006^{0}25′39.0′′E; 09^{0}30′57.8′′N, 006^{0}26′11.4′′E; 09^{0}32′02.6′′N, 006^{0}26′11.4′′E; 09^{0}32′02.6′′N, 006^{0}25′39.0′′E is subsumed in the wider Phase II. This is seen in the ArcMap platform of Fig.2. In relation to Phase I (i.e. the existing developed portion of the Gidan Kwano Campus), the satellite imagery overlay map showing the extent of this study is shown in Fig.3; on this figure, the tadpole-shaped feature is Phase I, seen to the east of the VES green-dotted grid of the area of study.

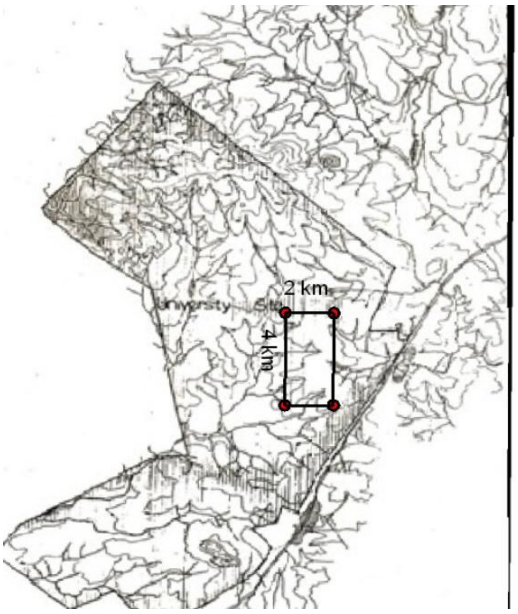

Fig.1. Location most suited for Phase II development at the Gidan Kwano Campus

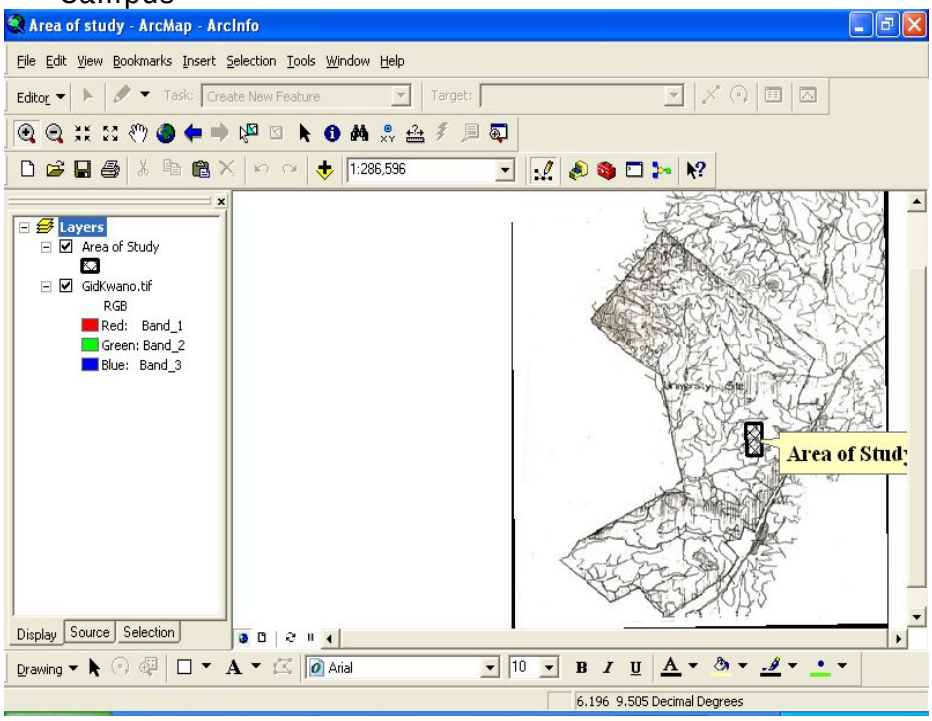

Fig.2: Extent of the 2km^2 area of study on the georeferenced map of the Gidan Kwano Campus presented on the ArcMap platform. (The extent of the GKC is 100km^2.)

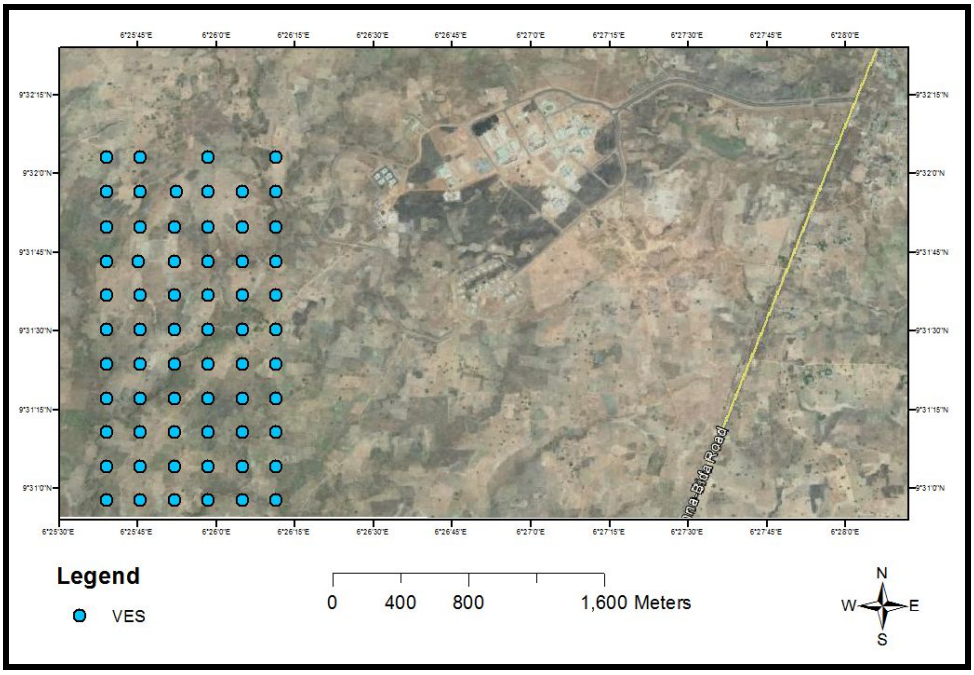

Fig.3: Satellite imagery overlay map showing the extent of project work in relation to Phase I. (The tadpole-shaped feature is Phase I, seen to the east of the VES green-dotted grid of the area of study.)

Brief Geology of the Gidan Kwano Campus

The area is underlain by Basement Complex rocks consisting of medium-grained biotite granite interbanded with coarse-grained leucocratic granite and intruded in places by quatzo-feldspar pegmatite dykes. The dykes strike parallel to the strike of the foliation, and they range from 0.5m to 3.5m in diameter. Outcrops are found along the river valleys as flat-lying bodies. They range in sizes from 3x5m to about 8x15m. Pinkish feldspar (i.e. potassium feldspar) is the dominant mineral in the granite gneiss and the pegmatite. This implies that its weathered product will be rich in clay. The rock types found here are believed to be part of older granite suite and are mostly exposed along the river channels where they appear in most cases weathered. Based on the relative grain size, the major rock types are (i) porphyritic coarse-grained granite, and (ii) medium to fine-grained granites. The former are mostly flat-lying with sizes ranging from few metres to about thirty metres. They are believed to continuously underlay the region that is covered by the thick overburden and are found outcropping along the river channels. Owing to biological weathering, the outcrops are broken into boulders. The latter are also flat-lying along the river channels and relatively high rising elongated outcrops on the surface, and unlike the pophyritic granite they are less weathered. The rocks are found in East-West (E-W) treading veins and joints which are sometimes filled by aplitic or quartz; this is in contrast to the porphyritic granite that are found in the North-South (N-S) trending quarts and aplitic veins ranging in length from 2m to about 15m. The medium to fine-grained granitic rocks are broken up into boulders in some places and they show the effect of weathering in the form of colour change, and loose rock fragments (Adesoye, 1986).

Co-ordinate Identification

Station-separation for the 2km^2 areal extent study area was fixed at 200m. What this means is that, along the north-south direction (longitudinal traverse or LT) there were six profiles and along the east-west direction (transverse traverse or TT) there were eleven profiles. At 200m station-separation, there are sixty-six principal stations slated for this survey. Suffice to recall that, because of the need to ensure independent verification of the results being presented, it is instructive to adopt the practice of georeferencing survey and eventual prospect stations. This georeferencing of survey stations requirement was achieved by visiting each of the principal stations and recording their respective latitude and longitude co-ordinates by means of the Garmin GPSmap76 hand-held global positioning system unit. The designation for these sixty-six principal stations and their respective latitude and longitude co-ordinates are given in Table 1.

Table 1. The sixty-six principal stations and their respective co-ordinates

TT	N	E
TT1-1	09°30′ 57.8′′	006°26′11.4′′
TT1-2	09°30′ 57.8′′	006°26′4.9′′
TT1-3	09°30′ 57.8′′	006°25′58.4′′
TT1-4	09°30′ 57.8′′	006°25′52.0′′
TT1-5	09°30′ 57.8′′	006°25′45.5′′
TT1-6	09°30′ 57.8′′	006°25′39.0′′
TT2-1	09°31′4.2′′	006°25′39.0′′
TT2-2	09°31′4.2′′	006°25′45.5′′
TT2-3	09°31′4.2′′	006°25′52.0′′
TT2-4	09°31′4.2′′	006°25′58.4′′
TT2-5	09°31′4.2′′	006°26′4.9′′
TT2-6	09°31′4.2′′	006°26′11.4′′
TT3-1	09°31′10.7′′	006°26′11.4′′
TT3-2	09°31′10.7′′	006°26′4.9′′
TT3-3	09°31′10.7′′	006°25′58.4′′
TT3-4	09°31′10.7′′	006°25′52.0′′
TT3-5	09°31′10.7′′	006°25′45.5′′
TT3-6	09°31′10.7′′	006°25′39.0′′
TT4-1	09°31′17.2′′	006°25′39.0′′
TT4-2	09°31′17.2′′	006°25′45.5′′
TT4-3	09°31′17.2′′	006°25′52.0′′
TT4-4	09°31′17.2′′	006°25′58.4′′
TT4-5	09°31′17.2′′	006°26′4.9′′
TT4-6	09°31′17.2′′	006°26′11.4′′
TT5-1	09°31′23.6′′	006°26′11.4′′
TT5-2	09°31′23.6′′	006° 26′4.9”
TT5-3	09°31′23.6′′	006°25′58.4′′
TT5-4	09°31′23.6′′	006°25′52.0′′
TT5-5	09°31′23.6′′	006°25′45.5′′
TT5-6	09°31′23.6′′	006°25′39.0′′
TT6-1	09°31′ 30.1′′	006°25′39.0′′
TT6-2	09°31′ 30.1′′	006°25′45.5′′
TT6-3	09°31′ 30.1′′	006°25′52.0′′
TT6-4	09°31′ 30.1′′	006°25′58.4′′

TT6-5	09°31′ 30.1′′	006°26′4.9′′
TT6-6	09°31′ 30.1′′	006°26′11.4′′
TT7-1	09°31′ 36.6′′	006°26′11.4′′
TT7-2	09°31′ 36.6′′	006°26′4.9′′
TT7-3	09°31′ 36.6′′	006°25′58.4′′
TT7-4	09°31′ 36.6′′	006°25′52.0′′
TT7-5	09°31′ 36.6′′	006°25′45.5′′
TT7-6	09°31′ 36.6′′	006°25′39.0′′
TT8-1	09°31′ 43.0′′	006°25′39.0′′
TT8-2	09°31′ 43.0′′	006°25′45.5′′
TT8-3	09°31′ 43.0′′	006°25′52.0′′
TT8-4	09°31′ 43.0′′	006°25′58.4′′
TT8-5	09°31′ 43.0′′	006°26′4.9′′
TT8-6	09°31′ 43.0′′	006°26′11.4′′
TT9-1	09°31′49.5′′	006°26′11.4′′
TT9-2	09°31′49.5′′	006° 26’4.9”
TT9-3	09°31′49.5′′	006°25′58.4′′
TT9-4	09°31′49.5′′	006°25′52.0′′
TT9-5	09°31′49.5′′	006°25′45.5′′
TT9-6	09°31′49.5′′	006°25′39.0′′
TT10-1	09°31′56.0′′	006°25′39.0′′
TT10-2	09°31′56.0′′	006°25′45.5′′
TT10-3	09°31′56.0′′	006°25′52.0′′
TT10-4	09°31′56.0′′	006°25′58.4′′
TT10-5	09°31′56.0′′	006°26′4.9′′
TT10-6	09°31′56.0′′	006°26′11.4′′
TT11-1	09°32′02.6′′	006°26′11.4′′
TT11-2	09°32′02.6′′	006° 26’4.9”
TT11-3	09°32′02.6′′	006°25′58.4′′
TT11-4	09°32′02.6′′	006°25′52.0′′
TT11-5	09°32′02.6′′	006°25′45.5′′
TT11-6	09°32′02.6′′	006°25′39.0′′

Data Collection Procedure

The Schlumberger array of the Vertical Electrical Sounding (VES) mode of the resistivity survey, which involved the artificial introduction of the default equipment factory-set value of current of 10mA (except where local geology does not permit this) into the ground through point electrodes, was employed throughout for the principal data collection phase of this project work. The resulting potential was compared with the particular default current value by the terrameter, thereby displaying the resistance value. Resistance values at sixty-four of the sixty-six principal stations that were identified for this survey were recorded; resistance values could not be measured for two VES stations because these locations correspond to the top of massive outcrops. There were twenty-seven sequences of measurements for each VES location, except where equipment glitch (usually battery-related problems do not permit this). The trend of the VES survey for this project work was in a transverse traverse (TT) sense, from TT1-1 to TT1-6, TT2-1 to TT2-6, and so on up to TT11-1 to TT11-6. Only stations TT11-2 and TT11-4 could not be surveyed in the course of this project exercise because their positions on the ground are exactly on top of bodies of outcrops; this omission may be inferred from Fig.3.

Data Processing

Conversion of Field Resistance Values to Resistivity Values: The initial processing step involved in the treatment of the dataset was the conversion of field resistance values to their corresponding resistivity values, usually taken to be the apparent resistivity values, which are the resistivity values of inhomogeneous earth. This was done by multiplying each of the field resistance values by their corresponding geometric factor.

Production of Resistivity Curves by WinResist®

Introduction: Usually, after determining the resistivity values from the field resistance values, it is desirable to generate curves, commonly log-log plots, showing the variation of resistivity values with the effective depth surveyed at that particular sequence for each VES station. It is recognized that the effective depth of penetration is equal to half the current electrodes spacing (if the current electrodes are separated by distance AB, then this AB/2). According to Zohdy (1989), a continuous variation of resistivity with depth curve is easily derived from multilayer step-function curve by drawing a curve that passes through the logarithmic midpoint of each vertical and horizontal line on the multilayer step function model. In view of the fact that the layer depths are logarithmically closely-shaped, the derived continuous variation of resistivity with depth model is equivalent to the original model. This approach makes it easy to construct maps of contoured resistivity values at different depths and to construct contoured geoelectric sections.

The WinResist® Approach: For this study, the field curves were obtained by plotting the apparent resistivity against half-current electrode spacing by the aid of the Windows-compatible WinResist® software. The initial outputs were the “default” graphs. These were further smoothed by iterations which were done in layers, thus resulting in final “modelled” outputs. The smoothed graphs are those that have connections to all the plotted points on the graph. Of the 63 resulting graphs, only 10 are presented here; these are shown as Figs 4 to 13. It must be pointed here that equipment glitch precluded the production of a field curve for TT1-1 because not enough sequence of dataset was collected at this location.

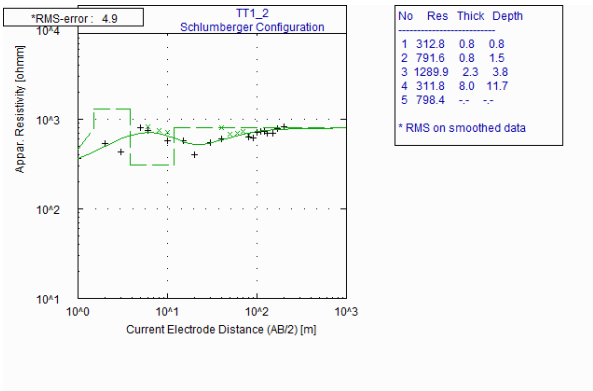

Fig. 4: WinResist® plot for TT1-2

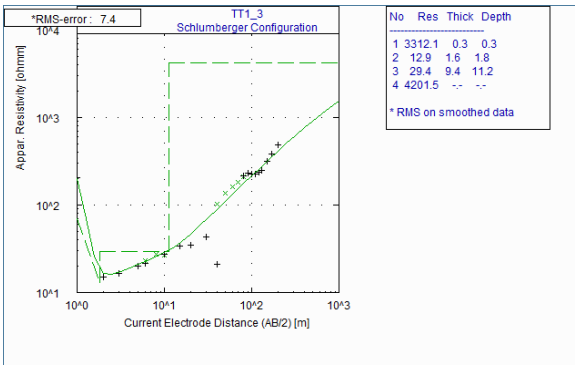

Fig. 5: WinResist® plot for TT1-3

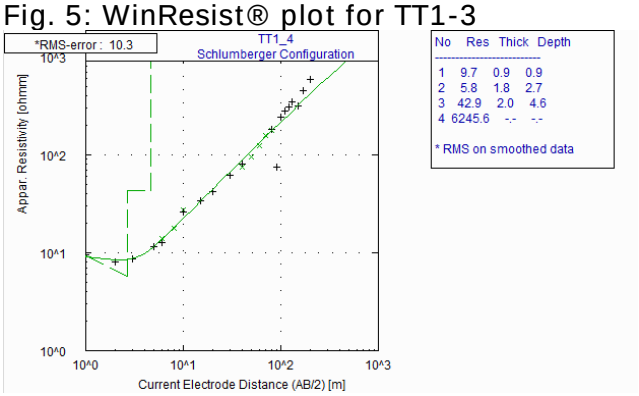

Fig. 6: WinResist® plot for TT1-4

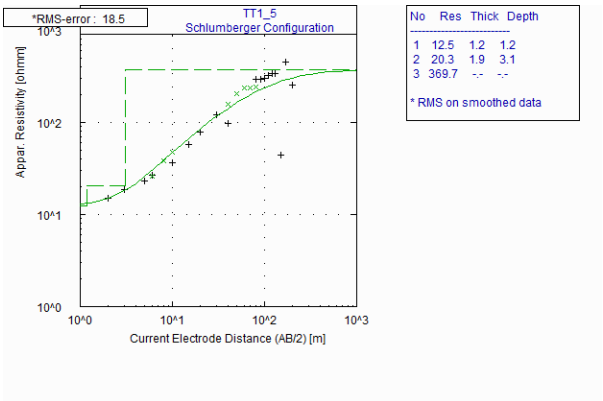

Fig. 7: WinResist® plot for TT1-5

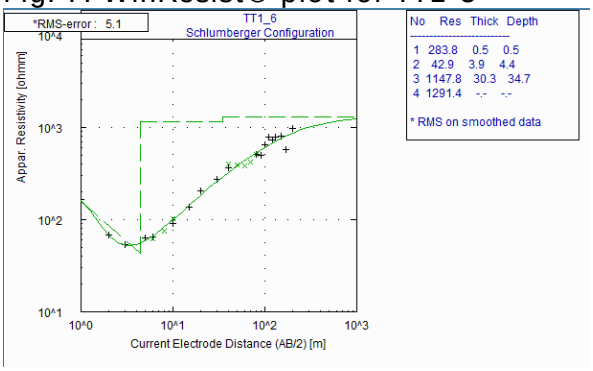

Fig. 8: WinResist® plot for TT1-6

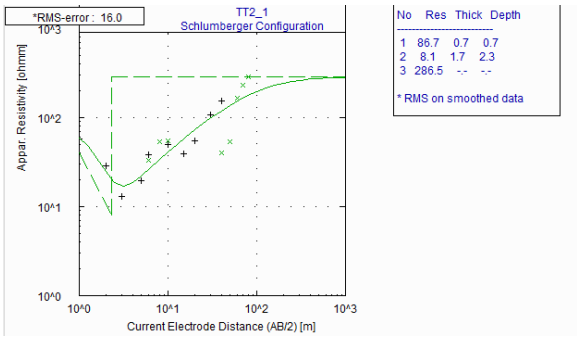

Fig. 9: WinResist® plot for TT2-1

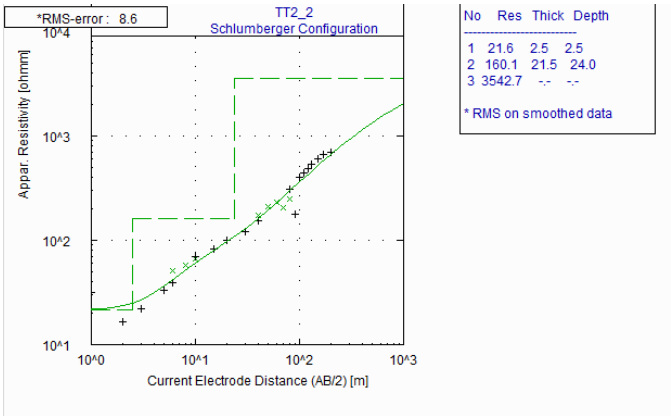

Fig.10: WinResist® plot for TT2-2

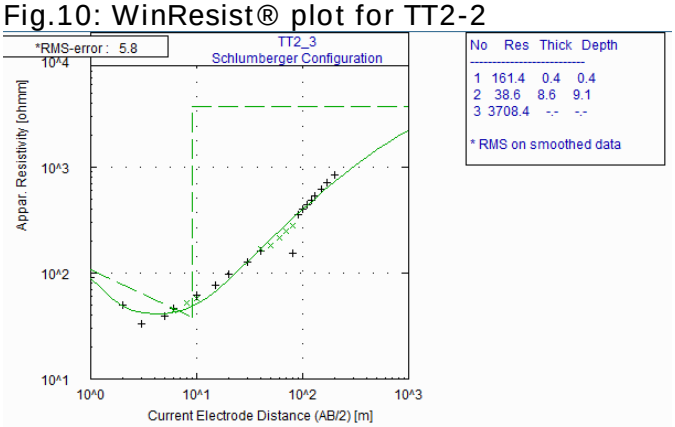

Fig.11: WinResist® plot for TT2-3

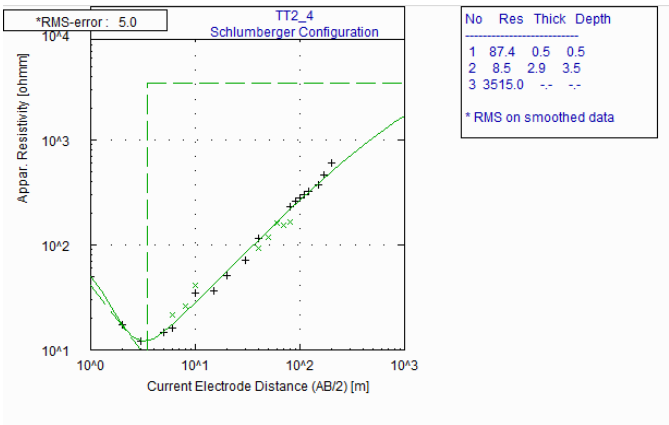

Fig.12: WinResist® plot for TT2-4

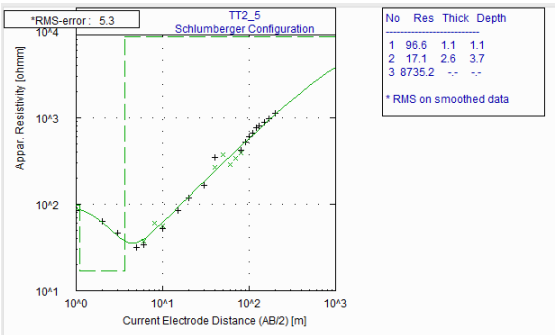

Fig.13: WinResist® plot for TT2-5

Production of Iso-Resistivity Maps at Depths: In order to show the variation of resistivity on a constant plane across the area of study, it is vital to produce resistivity maps at constant depths (i.e. the iso-resistivity maps). For this study, the Surfer® 10 software was used to generate the iso-resistivity maps at 20m, 30m, 40m, 50m. 60m, 70m. 80m. 90m, and 100m, see Figs 14 to 22. The Surfer® 10 package transforms the XYZ dataset (longitude, latitude, and resistivity values) to create contour maps and other useful graphic maps. Longitude and Latitude values in degree decimals for each of the sixty-four VES were chosen as X and Y respectively; X and Y values were varied with Z, and thence the values of resistivity at chosen depths.

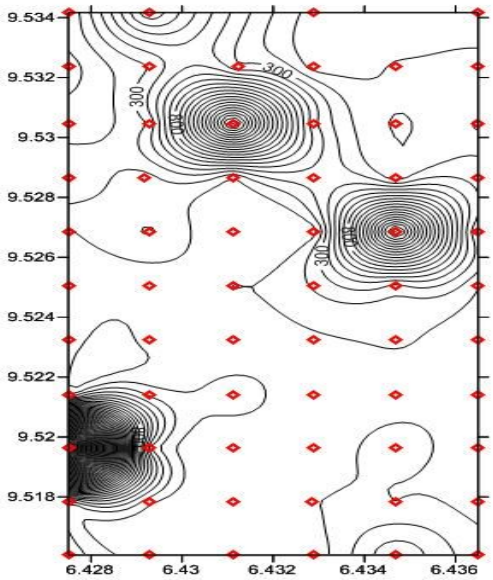

Fig.14: Iso-resistivity map at **20m (Contour interval: 100Ωm**)

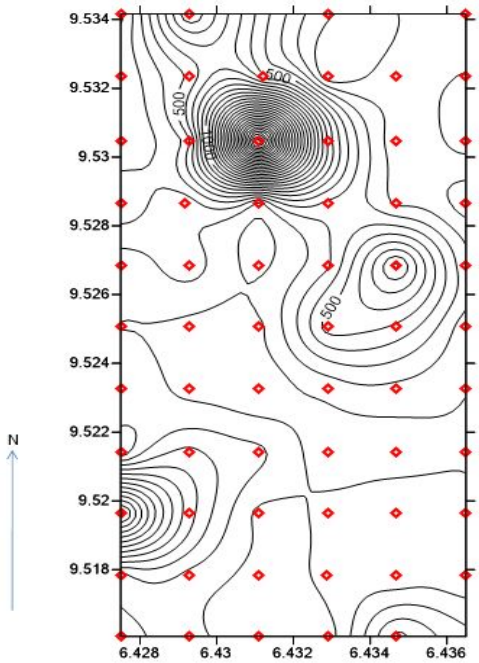

Fig.15: Iso-**resistivity map at 30m (Contour interval: 100Ωm**)

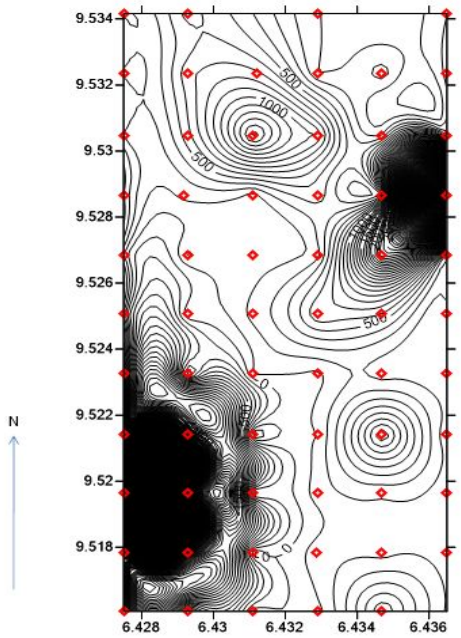

Fig.16: Iso-resistivity map a**t 40m (Contour interval: 100Ωm**)

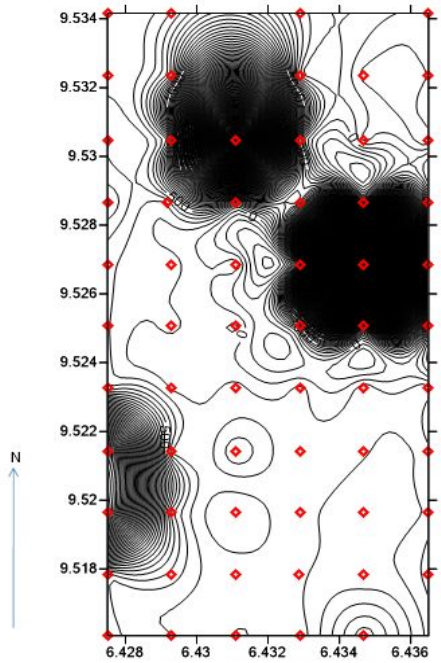

Fig.17: Iso-resistivity map a**t 50m (Contour interval: 100Ωm**)

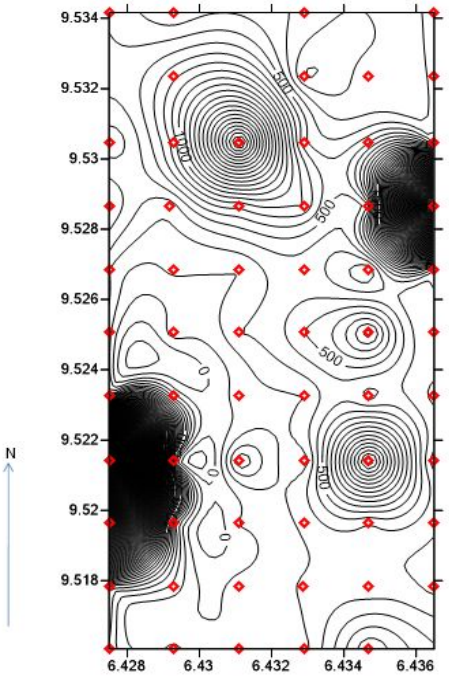

Fig.18: Iso-resistivity map at 6**0m (Contour interval: 100Ωm**)

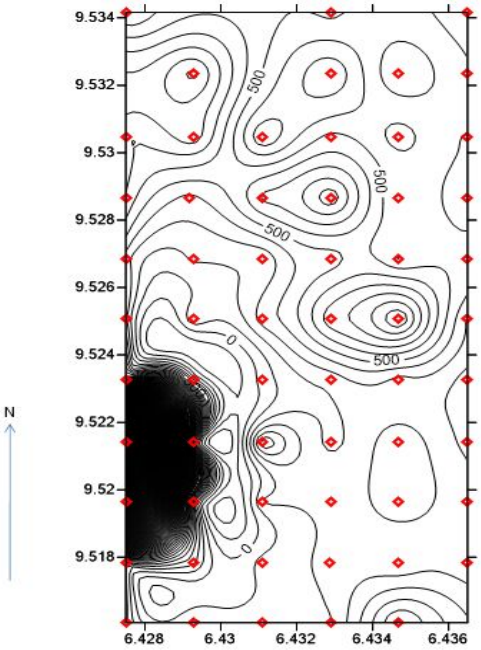

Fig.19: Iso-**resistivity map at 70m (Contour interval: 100Ωm**)

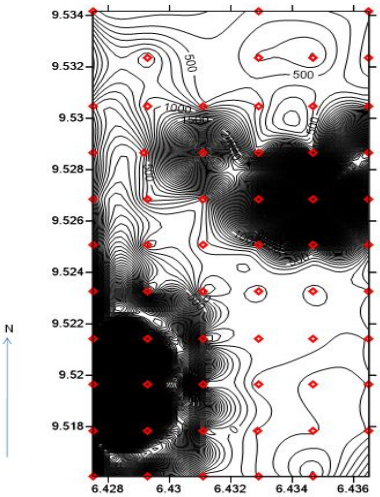

Fig.20: Iso-resistivity map a**t 80m (Contour interval: 100Ωm**)

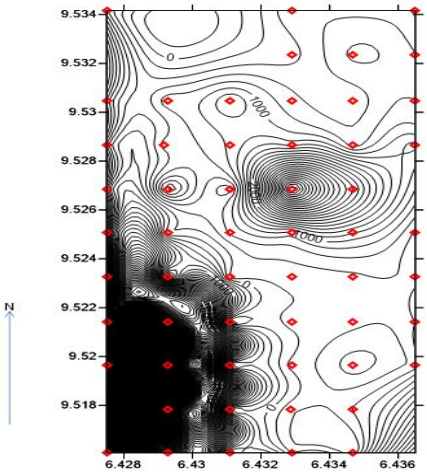

Fig.21: Iso-**resistivity map at 90m (Contour interval: 100Ωm**)

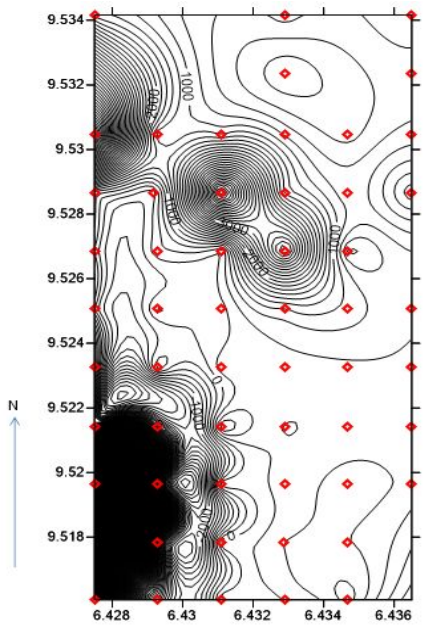

Fig.22: Iso-resistivity map at 1**00m (Contour interval: 100Ωm**)

Production of Depth Map for Geotechnical Information at the Study Area: The Surfer® 10 software was also employed to produce a depth map for geotechnical information at the study area, see Fig.23.

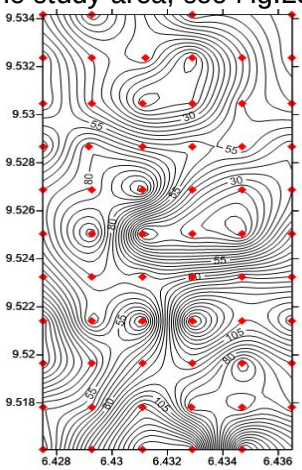

Fig. 23: Depth map for geotechnical information

Discussion of Result

On the "Geoexplore Empirical Standardization for Minna Area" and the Olasehinde Protocol:" Presently, there exist dual empirical rules to determine the likely presence of groundwater in the basement complex geological province. These rules are the "Geoexplore Empirical Standardization for Minna Area," enunciated in Jonah *et al.* (2013F) and the "Olasehinde Protocol," enunciated in Jonah *et al.* (2014A). For this study, the interpretation for aquifer prospects at the sixty-four VES locations was based on these rules. The "Geoexplore Empirical Standardization for Minna Area" states that ohmic resistance values of less than or equal to 0.3Ω at the 20m depth or greater (or, in resistivity terms, between 200Ωm and 300Ωm

at the 20m depth and less than 200Ωm at depths greater than 20m) is indicative of possible groundwater prospect. The "Olasehinde Protocol" states that resistivity values between 180Ωm and 250Ωm at the 20m to 25m depth mark are indicative of possible groundwater prospect. It is important to point out here that even though the resistivities of rocks do not depend on water content only, these informal laws are enunciated "rules-of-thumb" that serve as effective guides to groundwater prospectors out in the field. The bases of these protocols have been found to be effective over a two-decade period now for delineating approximate locations of groundwater yield (Olasehinde, 1989; 1999; Muftau Jimoh, personal communication).

The WinResist® Plots: Figs 9, 10, 11, 12, and are observed to be three-layered; Figs 5, 6, and 8 are observed to be four-layered; Fig. 4 is observed to be five-layered.

The Iso-Resistivity Maps at Depths: As a result of invoking the "Geoexplore Empirical Standardization for Minna Area" and the "Olasehinde Protocol" to determine aquifer prospect for this study, areas of contour closures corresponding to resistivity values well above 1000Ωm are necessarily ignored in our "geological prognosis."

The 20m-Depth Map:- At this depth, contour closures corresponding to resistivity values well above 1000Ωm are noticed at TT2-5 to TT2-6, TT3-5 to TT3-6, TT4-5 to TT4-6, TT7-1 to TT7-3, and TT9-3 to TT9-5.

The 30m-Depth Map:- It can be seen at this depth that dense cluster of contours of resistive value above 500Ωm occurs at TT3-5, TT3-6, TT6-1 to TT6-3, TT7-1 to TT7-3. Also resistivity value above 1000Ωm occurred at TT8-4, TT9-3, TT9-5, and TT10-3 to TT10-5.
The 40m-Depth Map:- At 40m depth, the contours are sparsely distributed and occur densely at TT2-5, TT2-6, TT3-5, TT3-6, TT4-5, TT4-6.

The 50m-Depth Map:- At this depth higher resistivity value above 50000Ωm can be seen at TT6-1 to TT6-3, TT7-1 to TT7-3, TT8-1 to TT8-2.

The 60m-Depth Map:- Corresponding resistivity values above 1000Ωm is observed at TT2-6, TT3-6, TT4-5, TT4-6, and TT5-6. Also at TT7-1,TT8-2,TT9-1,TT9-4 and TT9-5.

The 70m-Depth Map:- Very dense clusters are observed at TT2-6, TT3-5, TT3-6, TT4-5, TT4-6, TT5-5 and TT5-6. The contour closures correspond to a very high resistivity values.

The 80m-Depth Map:- Extremely high resistivity values are seen as thick contours closures at TT1-4 to TT1-6, TT2-4 to TT2-6, TT3-4 to TT3-6, TT4-4 to TT4-6, TT5-4 to TT5-6, also at TT6-1 to TT6-3, TT7-1 to TT7-3, TT8-1 to TT8-4.

The 90m-Depth Map:- At 90m sparsely distributed contours are seen except at TT2-5, TT2-6, TT3-5 and TT3-6.

The 100m-Depth Map:- Similarly to the 90m-depth, at 100m, contours closures are seen around TT2-5 and TT2-6, TT3-5 and TT3-6.

The Depth Map: The depth map, showing the variation of depth-to-top-of-bedrock across the area of study, shows a preponderance of contour closures in the southern half of the study

area; this can only mean the northern half is characterized by comparatively contour scatters. This preponderance of contour closures can only mean, too, that the southern half of the study area is characterized by thick overburden materials which, strictly speaking, are good for aquifer regime.

Conclusion

Extraction of Aquifer Information: As a result of invoking the "Geoexplore Empirical Standardization for Minna Area" and the "Olasehinde Protocol," the following VES stations are considered good prospects for aquifer: TT1-3, TT1-4, TT2-1, TT2-2, TT2-3, TT2-4, TT2-5, TT2-6, TT3-1, TT3-2, TT3-3, TT3-4, TT4-1, TT4-2, TT4-3, TT4-5, TT5-1, TT5-2, TT5-3, TT5-4, TT5-5, TT5-6, TT6-1, TT6-5, TT6-6, TT7-1, TT7-5, TT9-1, TT9-2, and TT9-6. These VES stations are spread throughout the study from the TT1s in the extreme south of the study area to the TT9s near extreme north of the study area. Now, imposing a tough groundwater prospect identification using the constraints of the "Geoexplore Empirical Standardization for Minna Area," the "Olasehinde Protocol," and the depth map of Fig.76 viewed for its overburden thickness character, the following VES locations are now flagged as "strongly aquiferous:" TT1-3, TT1-4, TT2-4, TT4-1, and TT4-3.

Extraction of Geotechnical Information: Fig. 23 provides a good guide for extracting geotechnical information for the area of study. The pattern of display of the contour lines of Fig.23 indicates that the regions where there are considerable contour closures correspond to areas of thin overburden! Since the northern half is characterized by comparatively contour scatters, this can only mean that the overburden thickness is comparatively thin here. Therefore the bedrock is not so deeply-seated as to prove a logistical challenge for site selection for buildings and other structural development. This is the situation observed at TT9-3, TT9-4, TT10-3 in particular, and other neighbouring TTs encompassing TT11-2 and TT11-4. Incidentally the region of all TT9s, TT10s, and TT11s are closest to the existing Phase I development.

Recommendation

It is recommended that the result of this study be adopted wholeheartedly by the Management of the Federal University of Technology, Minna, as a complementary document for the development of Phase II of the Gidan Kwano Campus.

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Appendix: Universities under survey

S/N	Universities	Year of Est.	Professionals	Para-Professionals	Total
1	University of Ilorin, Ilorin	1975	13	10	23
2	University of Jos, Jos	1975	22	20	42
3	Federal Univ. of Technology, Minna	1982	24	18	42
4	University of Abuja	1988	15	08	23
5	University of Agriculture, Makurdi	1988	13	45	58
6	Benue State University, Makurdi	1992	08	08	16
7	Kogi State University, Ayingba	1999	14	09	23
8	Nassarawa State University, Keffi	2002	05	05	10
9	National Open University of Nigeria, Abuja (Study Centre)	2003	04	01	05
10	Ibrahim Badamasi Babangida University, Lapai	2005	14	05	19
11	Al-Hikmah University, Ilorin	2005	06	01	07
12	Bingham University, New Karu	2005	06	-	06
13	University of Mkar, Mkar	2005	04	06	10
14	Salem University, Lokoja	2007	02	02	04
15	African University of Science and Technology, Abuja	2007	02	-	02
16	Kwara State University, Malete-Ilorin	2009	06	03	09
17	Nigerian Turkish Nile University, Abuja	2009	02	-	02
	Total		160	141	301

Source: NUC and Field Survey (2012)

RELATIONSHIP BETWEEN FACULTY STATUS AND JOB SATISFACTION OF LIBRARIANS IN NIGERIAN FEDERAL UNIVERSITY LIBRARIES: MIXED-METHOD APPROACH

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Abstract
Job satisfaction is a kind of comfort and ease a worker attaches to the job he performs which precipitates him to increase or decrease the level of efforts to the job assigned to him; While Faculty status is the agitation of librarians to be accorded with the same with the same entitlements and recognitions as the Faculty lecturers and similarly to enjoy the same condition of service.This paper examined job satisfaction of Librarians in Federal University Libraries in Nigeria with a view to determining their level of satisfaction on Faculty Status. Survey method was employed as a research technique. The sample size for the study comprises of (360) librarians in Federal University Libraries in Nigeria. Questionnaires and interviews were designed and used as instruments for data collection. Questionnaire data was analysed with the use of descriptive statistics (percentage, mean and standard deviation) and inferential statistics (Pearson Correlation). The interview was also transcribed and coded where key words of the questions and main ideas were extracted. The interview was then used to confirm findings from the questionnaire.The findings showed that overall; the librarians in the Federal University libraries are generally satisfied. However, there is no correlation between job satisfaction and faculty status. This study calls the policy makers to address the issue of faculty status of librarians to maximize their satisfaction for the effective provision of information and services to the academic community.

Key words: Job satisfaction, Librarian, University Libraries, Faculty status

Introduction
Job satisfaction in librarianship has generally been perceived as a recent field of inquiry, however, it could be argued that job satisfaction research is dated back to 1937 when Nourse (1937) conducted a research and reported low pay, work monotony, lack of promotion and lack of opportunity to take initiative as the causes of high staff turnover rate in libraries Job satisfaction as stated by Gliem and Gliem (2001) could be described as emotional and behavioural attitude of workers towards the work they perform.Faculty status on the other hand is the agitation of librarians to be given all entitlements and recognitions given to the faculty lecturers and ready to go through the some of the rigours and conditions of service with them (De Pew 1983).It is a well-known fact that, happy worker would be productive and satisfied a worker (Edem and Lawal, 1999). This is because job satisfaction affects the quality of the service rendered by the worker. It is however obvious that successful management of any organization depends largely upon high morale and satisfaction of the personnel in the organization. This means that a high-level job satisfaction is an important drive to the organization output. In Nigeria, contemporary researchers such as Adomi and Eruvwe, (2004),

Tella et al., (2007), and Baro et al., (2009), have investigated job satisfaction of librarians in Nigerian university libraries; but there is a dearth of studies that investigated the aggregate job satisfaction of librarians in Federal University Libraries in Nigeria.

Statement of the Problem

Since the beginning of economic recession in the early 1980s; its adverse effects are being felt on every sector including librarianship. The acquisitions of library materials and staff status have been in disarray. The hostile socio-economic environment in Nigeria according to (Edem and Lawal, 1999) makes one to wonder if librarians are satisfied with their job. The r issue about the socio-economic imbalance was a result of the absence of essential ingredients for satisfaction at work. For instance, there were no enough funds to purchase books and other library materials as well as paying the staff's salary and other remunerations such as excess work load over time and to take care of other conditions of service. This has led the librarians to be complaining and demonstrating lack of satisfaction with their jobs. It's also result to their poor attitude towards their work, thereby resulting into poor output. The spillover effect of this job dissatisfaction is the delayed or non-achievement of the organizational goals of the respective libraries.

Objective of the Study

Based on the above, this study intends to investigate the relationship between job satisfaction and faculty status of librarians in Federal University Libraries in Nigeria. To achieve this broad objective, the study will answer the followingresearch question:

Research Question

Is there any relationship between faculty status and job satisfaction of librarians in Federal University Libraries in Nigeria and"?

Literature Review

Hosburgh (2011) viewed that faculty status could be looked upon from two perspectives. Some people are of the opinion that librarians have no business operating under the rubric of faculty, while others opined that librarians have right to, and have won the status and must do everything in their power to keep it. The researcher proffered the most useful and widely accepted measuring tool as provided by the Association of College and Research Libraries' Standards for Faculty Status for College and University Librarians as prepared by the ACRL Committee on the Status of Academic Librarians (ACRL, 2007), in which Institutions of higher education and their governing bodies are urged to adopt the following standards, which basically define various aspects in which librarian faculty status is deemed equivalent to the faculty at large on a given campus.

(i) Librarians perform professional responsibilities.
(ii) Librarians have an academic form of governance for the library faculty.
(iii) Librarians have equal representation in all college or university governance.
(iv) Librarians receive compensation comparable to that of other faculty.
(v) Librarians are covered by tenure policies.
(vi) Librarians are promoted in rank based on a peer review system.
(vii) Librarians are eligible for sabbatical and other leaves in addition to research funds.
(viii) Librarians have the same academic freedom protections as other faculty (ACRL, 2007).

According to Ekoja and Adamu (2003) Academic/Faculty Status of librarians in Nigeria University Libraries has never been threatened at official level from Udoji Report of 1975 and Cookey Commission of 1981. The co-authors further elucidated that conferring librarians' academic or non-academic status in Nigerian Universities was not the official policy of government but the individual decision of each university's management until June, 1992 when all Universities in Nigeria accorded their librarians Academic Status following the Academic Staff Union of Nigerian Universities ASUU/Federal Government of Nigeria agreement that year. According to De Pew, (1983) many librarians who claim faculty status do so with no full confidence that fit the criteria lay down by the teaching faculty itself. Those who are totally comfortable in that role, fitting all the criteria, probably teach more than half a day anyway: in which case, are they librarians? Thus, Faculty Status has sometimes been confused with Academic Status. De Pew (1983) has shed more light on this difference by stating that:

> *Faculty status for librarians is the possession of all or most of the privileges of the faculty lecturers, including faculty rank. Academic status is the possession of some but not all-usual faculty privileges, as academics but always without faculty rank.*

Flaspohler (2009) examined the needs for librarians to enjoy sabbatical leave. Analyses were based on qualitative and quantitative data gathered using an online questionnaire. The researcher advised that academic librarians ought to increase their rigour, improve communication about their work and take greater accountability in such a way that their professional contributions would not affect their institutional value when they leave. The researcher further suggested that those librarians who manage to get out need to articulate the value of their experiences with more clarity and precision to their administrators and colleagues. In another development, Siegall and worth (2001) investigated the impacts of trust and control on faculty reactions to merit pay. The result from the Survey questionnaires found that, the more the faculty members trusted the administration the more they saw positive outcomes from the new system.

Berg, Jacobs and Cornwall (2013) examined how library administrators view the role of research in their own libraries and how they perceive the current and future climate for librarians' research in pursuance of academic status. The study revealed that, research is an expectation for every librarian that were most often outlined in collective agreements, performance evaluation documentation, job postings, job descriptions and workload documents but the librarians were moderately or slightly active in their level of research and scholarly activity. The study further showed that the expectations placed on librarians to publish within the scholarly literature, is adequate, though, the librarians found lack of skills and motivation, as key barriers to academic librarians' research, while lack of funds, time, and support as greater barriers. Ideal time spent on research by the librarians at their institutions is between 0 and 20 percent of their time doing scholarly activities. The only supports made available to librarians taking part in research and scholarships at their institutions are research leaves and sabbaticals. These two most common supports are also those most which were often dictated by collective agreements and employment contracts. But supports that are more voluntary and less formalized such as peer support groups, mentoring programs, and research assistance were less commonly available

Baro et al (2009) conducted a research on gender and publication output of librarians in Edo and Delta State University Libraries in Nigeria. The researchers found out that male librarians published more than their female counterparts. They also revealed that female family responsibilities were the major factors hindering them from publishing equally as their male counterparts. Building on the preceding discussion, this study intends to investigate the effect of faculty status on job satisfaction of librarians in Federal University Libraries in Nigeria.

Wyss (2010) surveyed the ALA-accredited library schools perceptions regarding faculty status for academic librarians and how education at library school prepares academic librarians for faculty roles. The researcher, found that, ALA-accredited library schools are of the opinion that during the preparation of curricula on academic librarians for faculty status. It should be enshrined that research courses and statistical courses are required of doctoral and M.L.S. students, because M.L.S. is not a sufficient preparation for faculty status it should therefore be supplemented with a doctoral degree. The study also revealed that academic librarians are though at disadvantaged in producing research because of their daily responsibilities, they should be covered by the same tenure policy and publication standards with doctoral degree requirement for promotion to full professor but they should not be on the same evaluation criteria with teaching faculty. Librarians are therefore encouraged to be involved in library governance, as well as university governance because their Involvement in university governance earns their credibility. The study support the eligibility of librarians eligible for the same sabbatical and research leaves as teaching faculty because sabbatical and research leaves, facilitate research and improve publication rates

Methodology

Survey method was employed using qualitative and quantitative techniques Survey technique is considered very suitable for this study because, it focuses attention on a large population spread across the given area (Best and Khan, 2003).

The population of the study consulted of the entire librarians in 36 Nigerian Federal University libraries. But 20 librarians were considered in each of the 18 University Libraries randomly selected for the study based on the six geo-political zones, where three university libraries are selected in each zone.

A sample of 360 librarians was selected through stratified random sampling. This technique allows the researcher to make inferences about a population based on the nature of the sample. The population was stratified into six geo-political zones i.e. North West, North East, and North Central, South Western, South Eastern and South Southern. At least three university libraries from each zone were chosen for sampling (see table 1).

Table 1: The geographical distribution of Nigerian Universities

Geo-Political Zones	Selected Universities
North Central	University of Ilorin, Ilorin
	University of Agriculture, Makurdi
	Federal University of Technology, Minna.
North Eastern	Federal University of Technology, Yola.
	Abubakar Tafawa Balewa University, Bauchi.
	University of Maiduguri, Maiduguri.
North Western	Ahmadu Bello University, Zaria.

	Bayero University, Kano.
	Usman Danfodio University, Sokoto.
South Eastern	Federal University of Technology, Owerri.
	University of Agriculture, Umudike, Umuahia.
	University of Nigeria, Nsukka, Nsukka,
South Southern	University of Port-Harcourt, Port-Harcourt
	University of Uyo, Uyo.
	University of Calabar, Calabar.
South Western	University of Agriculture, Abeokuta.
	University of Lagos, Akoka.
	University of Ibadan, Ibadan.

Sample size is therefore, the true representative samples from which generalization can be made to the population (Burns, 2000). Thus, having stratified the population into six geo-political zones, three university libraries were drawn from each stratum. The librarians from each of the three University Libraries in each of the geo-political zones of the Federal University Libraries were considered. Twenty (20) librarians selected from each of the 18 sampled Federal University Libraries amounted to a total of 360 represent the sample for the study.

The study adopts Job Satisfaction Survey instrument developed by Spector (1985) for special use of human service, profit and non-profit organizations. This research tool was considered to be very appropriate and suitable for data collection in this study. The researcher selects nine specific job satisfaction indicators. Each of them is presented as an evaluative statement that tests the attitude towards the nine indicators of job satisfaction. They include: Benefit, Communication, Contingent Reward, Co-Workers, Operation Procedure, Supervision, Pay, Promotion, and Work Itself.

Copies of questionnaires were administered to the entire 360 librarians to examine the significant relationship between faculty status and their job satisfaction. A follow up interview was conducted with six senior librarians, one from a university library from each of the geo-political zones to seek their opinions and perceptions on their satisfaction in relation to faculty status. Collected data through questionnaire administration was analysed quantitatively using percentages and frequency count.

Results

This section presents data analysis and interpretation of results.

Table 2 below presents the detailed description of the respondents' responses to questionnaire items on faculty status.

Table 2: Descriptive analysis of faculty status

S/N	Statement	Agreed		Disagreed		Neutral	
		N	%	N	%	N	%
1	I enjoy faculty status in my institution	158	61.9	52	20.7	41	16.3
2	There is no difference between faculty status and academic status	121	48.2	77	30.7	53	21.1
3	My librarianship duties did not hinder me from publishing in	197	78.5	26	10.4	28	11.2

	reputable journals						
4	I participate in teaching in the faculty in addition to my library work	155	61.7	65	25.9	31	12.4
5	I participate in the supervision of projects and examinations	101	40.3	114	45.4	36	14.3
6	I am given the opportunity to attend learned conference	198	78.1	27	10.8	28	11.2
7	I participate in the assessment of teaching practice / practical attachment	132	52.6	73	29.3	46	18.3
8	No opportunity is given to me to go on sabbatical leave unlike the faculty lecturers	85	43.9	112	44.6	54	21.5
9	There is an opportunity to become professor without moving out of the library to the faculty	113	46.2	92	36.6	43	17.1
10	Academic work provides opportunity for self-development	219	91.3	7	2.8	15	6.0
11	There should be opportunity for more than one person to rise to a position of university librarian as having more than one professor in the faculty.	182	72.5	30	12	39	15.5
12	I publish in local journals than foreign ones	169	64.1	36	14.4	54	21.5
13	I enjoy staff development fund for my further studies	117	46.6	84	33.4	50	19.9
14	Waiting period for deputy university librarian to become university librarian is too long	151	62	37	14.8	63	25.1
15	People from the faculty should stop heading the library.	180	91.7	28	11.2	43	17.1
	Total	2278	919.6	860	343	624	248.5
	Total average mean	151.86	61.30	57.33	22,8	41.60	16.56

Table 2 above indicates that about three-quarter (61.3%) of librarians agreed, to be satisfied with faculty status, but 22.8% disagreed; while 16.6% neither agreed nor disagreed with the questionnaire items on faculty status.

Table 3presents the detailed description of the respondents' responses to questionnaire items on job satisfaction dimensions.

Table 3: Descriptive analysis of job satisfaction dimensions

	Agreed		Disagreed		Neutral	
	N	%	N	%	N	%
Benefit	162.8	64.77	41.8	16.74	46.3	18.47
Contingent reward	106	42.24	92.57	36.97	52.4	20.87
Promotion	179.63	66.43	40.63	15.79	43.6	17.38
Pay	138.13	54.63	68	25.42	45	17.91
Co-Workers	199.63	80.86	15.25	6.1	33.4	13.3
Operation Procedure	150.75	59.58	30.5	12.18	6.9	27.5
Work Itself	218.5	87.1	7	2.75	25.5	10.15
Supervision	179.57	49.24	30	14.03	41.1	16.27
Communication	171.3	68.12	32.67	14.78	43.8	18.77
Total	1506.3	573.0	358.4	144.8	400.2	160.6
Total average	167	63.7	39.8	16.1	44.5	17.9

Table 3 showed the descriptive analysis of respondents' responses on job satisfaction dimensions. The overall result showed that about two-third (63.7%) agreed to be satisfied with the job satisfaction dimensions, but 16.1% of the respondents disagreed, while 17.9% were neutral.

Inferential Analysis

Pearson Product-moment correlation coefficient analysis was carried out to determine the significant relationship between faculty status and job satisfaction of librarians in Nigerian Federal University Libraries. Table 4 provides the summary of descriptive statistics such as mean, standard deviation and skewness and kurtosis. Based on analysis, the value of skewness and kurtosis, is between positive and negative in no case did it reach the cut off value of 3. This reveals that the data is normally distributed (Fah & Hoon, 2009).

Table 4: Descriptive summary statistics

Variables	Min	Max	Mean	SD	Skwness	Kurtosis
Job satisfaction	2	5	4.162	.562	-.721	1.817
Faculty status	1	5	3.205	1.10	-.244	-.648

The Pearson Product-moment correlation coefficient analysis presented in table 5 shows that there is no significant correlation between job satisfaction and faculty status r = 0.095, n = 251, *P* = 0.133 greater than alpha level .05, implying no relationship between faculty status and job satisfaction.

Table 5: Correlation matrix

		Jobsat	Faculty status
Mean		4.1624	3.2052
Standard deviation		.56239	1.09487
Job satisfaction	Pearson Correlation	1	.095
	Sig. (2-tailed)	-	.133
Faculty status	Pearson Correlation	.095	1
	Sig. (2-tailed)	.133	-

Interview Research Question

Understanding on about Faculty Status of Librarians in Nigeria: The interview question intended to explore the perception and understanding of librarians on faculty status. The respondents described faculty status as the status of faculty lecturers, equal status with teaching staff and undergoing same rigours as applicable to faculty lecturers. This could be summarized that faculty status according to the respondents is the equal treatment with the faculty lecturers.

Faculty Status and Job Satisfaction: The question intended to explore feelings and yearning of the librarians for the faculty status. The respondents indicate that it enhances the participation in academic activities and it has positive effect. The general observation is that faculty status has a positive effect on job satisfaction of librarians.

The area yet to be addressed by the faculty status in relation to job satisfaction of librarians: The question explores the perceptions and feelings of librarians on faculty status. The respondents expressed their feelings that: Faculty status has not fully addressed the issue of upgrading the status of librarians to that of faculty lecturers; No provision of excess workload; they advocate for equal treatment and dislike unequal ranking system with the faculty lecturers. The summary is that the status of the librarians should be upgrade to the true status of the faculty lecturers.

The promotion of the deputy university librarians to the position of the professorship: All the respondents reacted positively to the above question that it is a welcomed idea and a right step in the right direction. The conclusion is that there should be more opportunities for the librarians to become professors or its equivalent (university librarian).

Unionism andFaculty Status: Unionism and faculty status in Nigerian context go hand-in-hand. It was through unionism that librarians fought for parity in this status with faculty lecturers. Mostly in Nigeria and many other countries in the world, workers fight for their rights through trade unions. As already explained that unionism looks after the welfare of their members and in most cases advocates for their rights through any legal means. Sometimes they go to the extreme by going on industrial action.

The responses of the respondents to unionism include: Unionism strengthens the librarians' struggling, but has not yet addressed the issue of faculty status properly; unionism helped in the quest for the better service condition. The summary is that unionism engineered the betterment of librarians' job satisfaction through faculty status.

Discussion of Results

Faculty status in librarianship is the demand of the professional librarians to have same status with academic staff and go through the same rigours and conditions of service with the lecturers in the faculty. The findings from the descriptive results revealed that about three quarter of the librarians enjoyed faculty status in their institution though there is a difference between faculty status and academic status. Eight percent (8%)of the librarians published in reputable journals alongside their librarianship duties. More than sixty percent (60%) participated in teaching in the faculty and less than half participated in the supervision of projects and examination. High proportions were given opportunity to attend learned conference. More than half participated in the assessment of teaching practice and practical attachment; Less than half (43.9%) were given opportunity to go on sabbatical leave.

The findings also revealed that academic work encouraged the librarians to be self-developed that was why more than 60% published in local and foreign journals, though less than half of the respondent enjoyed staff development fund for their further studies. The finding also showed that there should be more opportunities for more than one person to rise to the position of university librarian and the waiting period for the deputy university librarians to become university librarians is too long. And above all, people from the faculty should stop heading the library. The overall result revealed that majority of the respondents gave good responses to faculty status, though there were some crucial areas needed to be addressed on faculty status to enhance the job satisfaction of the librarians. One of these areas is staff development of which Hart (2001) found that staff development was rather sparse and no opportunity is given to the librarian for growth, training and personal development.

The findings from the inferential results showed that there was no significant relationship between job satisfaction and faculty status. This implies that increase in faculty status may not lead to job satisfaction. In support of the above finding, Bryan (2007) reported a negative correlation between personnel status of librarians and overall satisfaction in relation to rank. The researcher found that the higher the rank of an institution the less likely the librarians had faculty status.

The findings from the interview revealed that, though, librarians were moderately satisfied with the faculty status, there were still some issues not yet well addressed by the faculty status. The reactions of librarians on faculty status were revealed through their responses to the interview questions under faculty status. They are as follows: The finding reveals that all the respondents understood what faculty status meant. This is reflected in their responses to the interview question on their knowledge on faculty status.

“Equal status with teaching staff”, “Some rigour as applicable to the faculty lecturers”, “Equal treatment with faculty lecturers”

The finding also showed that faculty status induces job satisfaction of librarians. It also enhances their participation in academic activities. Generally, faculty status has positive effect on the respondents’ satisfaction. Their responses to the above interview question are:
“It has positive effect “, “Enhancement of participation in academic activities”. The study also showed that there are more areas not yet addressed by faculty status. The respondents’ responses were buttressed by the following.

“Upgrading librarians’ status is yet to been fully addressed”, “Unequal ranking has not be fully addressed”, “Equal treatment with faculty lecturers in terms of excess workload, training and development has not been fully accorded”.

Findings further revealed that there should be a designation between the rank of Deputy University librarian and University librarians. This will allow many librarians stagnated on the Rank of Deputy University Librarians to rise to the position of professorship. Their responses include: “A welcome development”, “I think there should be readers while the University librarians should be in the same position as professor”.

The general finding was that unionism has helped a lot to make job satisfactory for librarians. Correspondingly Garcha and Philips, (2001) found that though union membership gave librarians a great sense of job security, nothing they could rely on union's assistance in the event of any problems they had with administration.

Conclusion

The findings revealed that there was no correlation between job satisfaction of Librarians in the Federal University Libraries in Nigeria and faculty status. Similarly, the findings from the interview of Librarians in the Federal University Libraries in Nigeria corroborate with the correlation This implies that the Faculty Status of librarians, according to the findings, has not fully addressed the disparity between librarians and lecturers in the faculty.

Though, the descriptive results revealed that respondents agreed to have faculty status and agreed with the job satisfaction dimensions except the contingent reward, the inferential findings revealed that Faculty Status had no significant relationship with job satisfaction of the librarians in the Federal University Libraries in Nigeria. The differences in the findings of descriptive and inferential results were reconciled by the responses from the interview conducted among the respondents. Majority of respondents interviewed expressed their dissatisfaction with the unequal treatment of faculty status of librarians with the lecturers in the faculty.

This study calls on the policy makers such as: Library Management, University Management and Library Associations, to rise up to address issues that are hindrances to job satisfaction of librarians; because dissatisfaction of librarians may hinder the effective provision of information and services for teaching, learning and research purposes in the academic community.

Recommendations

The following recommendations are made:

(i) The librarians should be given more opportunities to participate in the supervision of projects and examinations.

(ii) They should be given more opportunities to go on sabbatical leave like the faculty lecturer.

(iii) There should be more opportunitiesfor the librarians to be become professors without moving out of the library to the faculty.

(iv) There should be more opportunities for more than one person to rise to a position of University Librarian or its equivalent as having more than one professor in the faculty. This more so because, the waiting period for the Deputy University Librarian to become the University Librarian is too long and only one of the Deputy University Librarians could be a lucky one.

(v) The Librariansshould be given more opportunities to enjoy staff development fund to further their studies.

(vi) The issue of faculty status should be fully addressed though provision of excess world load and equal ranking treatment.

(vii) The librarians should always publish in reputable journals alongside their librarianship duties.

(viii) There should be adequate provision of staff development.

(ix) Lecturers from the faculty should stop heading the library as they have their own opportunities to become the HOD or Dean in their various faculties. Secondly, they have

little experience on how the library should be run because they have not been involved in the day to day administration of the library right from the onset.

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RADIOGENIC HEAT PRODUCTION IN THE CRUST USING HIGH RESOLUTION AERORADIOMETRIC (HRAR) DATA IN PARTS OF SOKOTO BASIN, NIGERIA

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Abstract

Measurement of radiogenic heat production has been carried out from the gamma ray spectroscopy of the high resolution aero radiometric (HRAR) data for parts of the Sokoto Basin in northwestern Nigeria. Ten sheets of total count map for the study area showing combine effects of ^{40}K, ^{238}U and ^{232}Th for the area were analyzed into potassium content map, uranium content map and thorium content map. The contribution and rate of heat production from the content maps were calculated. The results of the analyses show that the crustal radiogenic heat production (RHP) rate for the selected sections ranges from 0.07 to 5.48 μWm^{-3} with an average of 1.07 μWm^{-3} for 5,153 values. Some of the areas with radiometric anomaly, are lithologically consistent with limestone, granite and shale which are known to have the highest concentration of ^{40}K, ^{238}U and ^{232}Th. They are long lived isotopes of interest in the radioactive decay of the earth's crust. Using Rybach average of 2.25 μWm^{-3} for rocks and sedimentary formation as the standard. The Sokwoi Binji, Kaoje, and Konkwosso areas which have RHP values of 1.56 μWm^{-3}, 1.52 μWm^{-3}, 2.03μWm^{-3} and 1.79 μWm^{-3} respectively, may not be prospect areas for geothermal exploration. But the Kalmalo, Sokoto, Argungu, Dange, Birnin Kebbi and Giru with radiogenic heat production values of 3.62 μWm^{3}, 3.10 μWm^{-3}, 2.82 μWm^{-3}, 5.48 μWm^{-3}, 2.70 μWm^{-3} and 2.67 μWm^{-3} respectively, have RHP values found to be due to high heat production of ^{238}U are suggestive of anomalous geothermal conditions, may be good areas for geothermal exploration that can be tapped as an alternative to fossil fuel based energy in Nigeria and therefore are recommended for detailed ground radiometric survey and lab.tests.

Keywords: Aeroradiometric, Radiogenic, Geothermal, Sokoto Basin, Nigeria

Introduction

Airborne gamma ray spectroscopy (AGRS) measurement was used to carry out regional estimation of concentration of heat producing elements (HPE) in the Earth's crust in counts per second of the sedimentary rocks and igneous rocks of the crust. The decay of long life radioactive elements of interest for geothermal resources are ^{40}K, ^{238}U and ^{232}Th in the Precambrian basement that are largely covered by younger sedimentary and granitic rocks gives out geothermal heat that is radiogenic in nature. It is accompanied by the emission of radiation such as alpha particles, beta particles, gamma ray, neutron and proton. The gamma particles are high energy electromagnetic radiation with characteristic energy for each decay reaction. Their spectrum can be used to determine the concentration of different isotopes that decay (Gilmore, 2008).

The aeroradiometric survey counter that can be 80 -100 m above the surface could penetrate up to 0.005 km through rocks is mostly used for regional survey of gamma radiation emitted

and penetrated close to surface of the crust. Hence, radiometric method is capable of yielding information only on what lies at the ground surface it provide regional information on geothermal resources by remote sensing Moxlami (1960). It is a fast and cost effective method because it is usually conducted with multiple sensor that can simultaneously measures radiometric, magnetic and electromagnetic data. Similarly, there is no limit accessibility to any part of the study area be it ocean, swampy, rocky magmatic mountain, valley etc one major disadvantage is that the cost of chartering air craft are not trivial.

The spectral radiometric measurement can be used to evaluate radiogenic heat production (RHP) rate, which is the amount of heat librated in unit time in unit volume of rocks by the decay of radiogenic isotopes, its unit is Wm^{-3}, but are only sensitive to a very thin surface layer of the earth's crust. The average RHP can be used to rank, to know the major element responsible for the RHP in the area, from airborne gamma ray data in space survey along a set of parallel flight lines profile 2 km apart. In the past AGRS has been used for uranium exploration, but following advancement in technology many instrument and field guideline, this method is now used as general mapping and exploration tool for several environmental and geosciences studies.

The Nigerian Geological Survey Agency (NGSA) carried out a nationwide airborne radiometric survey in 2009 with the aim diversifying the country's economy from mono product economy to other sector. Regional high resolution aeroradiometic (HRAR) data were acquired in Nigeria by Fugro Airborne Survey Limited for the NGSA between 2004 and 2009. The acquisition, processing and compilation of the new data were jointly financed by the Federal Government of Nigeria and the World Bank as part of the Sustainable Management for Mineral Resources Project (SMMRP). The airborne gamma ray spectrometer surveys, using Scintillation detector as counters with data recording interval of 0.1 seconds, were carried out by means of Fixed-wing aircrafts flown at mean terrain clearance of 80 m with 500 m line spacing and nominal tie-line spacing of 2 km. The flight line and tie-line trends were 135 and 45 degrees respectively. Unlike the preceding surveys that were done with the 1970's data, in an analogue paper map format from a flight height of 152 m with line spacing of 2 km and nominal tie-line spacing of 20 km; earlier studies with 1970's data such as (Ofoegbu, 1984; 1985; 1986; Nwachukwu, 1985.), they pointed out the need to shift from analogue to digital since 1970's, the stressful work of digitizing a map and the likely human error that could be introduced during the processing and correction of errors as problems.

These problems have all been eliminated because the HRAR data is in a digital format. Previous studies (Paoletti *et al.*,2005a and 2005b) showed that it provided an insights into the characterization of the buried, geological and outcropping volcanic structure of an area. It is rich in high frequency anomalies not shown in the previous regional low resolution data, and locate buried structures such as lineament, faults and volcanic and intrusive structures, hence it help in enhancing the knowledge given by previous low resolution studies. Thereby providing a better understanding of the buried, geologic, tectonic, geovolcanological and geothermal characteristics of an area. This new HRAR data is widely adjudged to be better and it is assumed that its analysis would provide better and improved geoscientific outcomes. Research in this topic on this area were lacking. This work aimed at identifying clean and renewable energy sources that can be a better alternative to burning fossil fuels that can lead to emission of green house gases. Green house gases trap heat (long wave radiation) in the atmosphere keeping the earth's surface warmer than it would be if they were not present. This can lead to

global warming and climate change, it involves calculation of RHP from radioelements concentration of geothermal resources for possible generation of alternative energy sources to the traditional fossil fuel based energy in Nigeria, has fills the gap of lacking baseline geothermal data and avoids mistakes that have been previously made.

Location and geology of the study area

The Sokoto Basin is located in the northwestern part of Nigeria and is bounded by latitudes 10.00°N and 14.00°N and longitudes 3.50°E and 7.00°E (Fig. 1). It has a total surface area of about 111,925 km^2, which cuts across six provincial states in Nigeria, namely Kaduna, Katsina, Kebbi, Niger, Sokoto and Zamfara.

Sokoto basin, which has been extensively described by geologists (Kogbe, 1979; 1981; Obaje, 2009), constitutes the south-eastern portion of the Iullemmeden basin. Iullemmeden basin extends from Mali and the western boundary of Niger Republic through northern Benin Republic and north-west of Nigeria into eastern Niger Republic. The entire Iullemmeden basin covers an area of about 800,000 km^2. The rock unit are predominantly clay alternating with gritty sand unit, which are ill-stored, poorly consolidated with gravel overlying the precambrian basement and consist of a gentle undulating plain with an average elevation varying from 250 to 400m above sea-level (Kogbe, 1979).

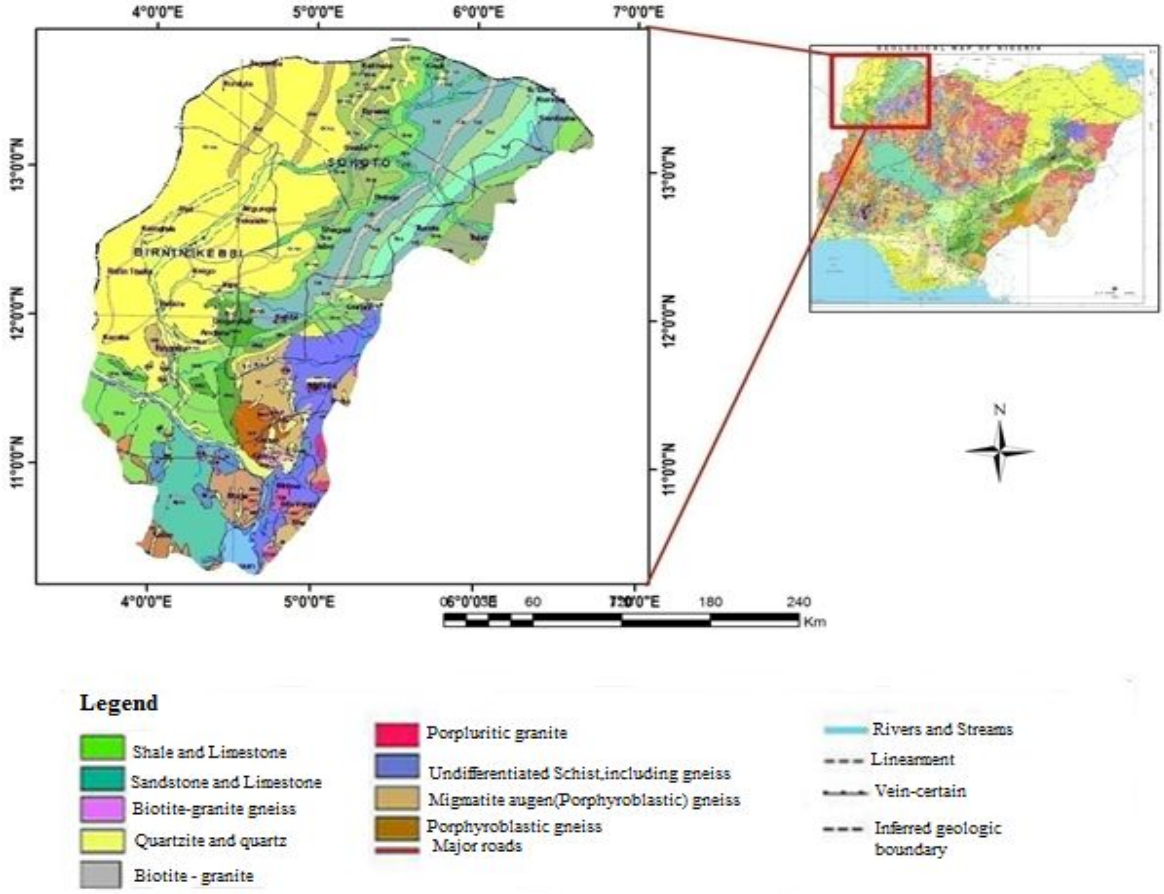

Fig. 1: Geologic map of Sokoto Basin (After Nigerian Geological Survey Agency, 2009)

The Nigerian sector of the basin is underlain to the east and south by precambrian basement rock consisting of igneous and metamorphic rocks, and to the north in the Tassaili and the Hoggar mountains by cambrian beds. The sediments of the Sokoto basin were deposited under varied environmental situations ranging from continental to marine events. The sedimentary rocks of the basin range in age from Pre-Maastrichtian to Eocene. (Fig. 2) have been classified under four major stratigraphic categories (Kogbe, 1979; 1981):

(i) The Illo and Gundumi formations overlying the precambrian basement unconformably, which is made up of grits and clays.
(ii) Maastrichtian Rima group, consisting of mud stone and friable sandstone called Taloka and Wurno formation separated by the fossiliferous and shelly Dukamaje formation.
(iii) The Dange and Gamba formation (mainly shale) separated by the calcareous kalambaina formation known as Sokoto group and is of marine origin.
(iv) The Gwandu formation forms the post-paleocene continental terminal, which occurs in the northwest and southern parts of Sokoto. This sediment dips gently and thickens gradually towards the northwest, with a maximum thickness of over 1,200 m near the frontier with Niger republic.

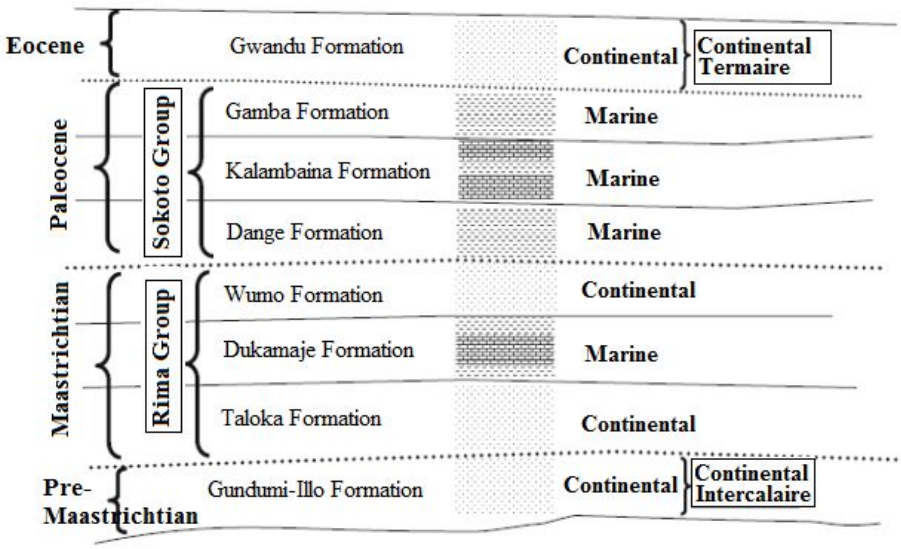

Fig. 2: Stratigraphic sequence of the Sokoto Basin (After Obaje, 2009)

Radiometric Method

The total count map for the study area showing combine effects of ^{40}K, ^{238}U and ^{232}Th for the area were analyzed into Potassium content map, uranium content map and thorium content map. The contribution and rate of heat production from the content maps were calculated. Using equation 1a, and consequently the RHP in rocks was evaluated

$$Q = \rho (0.035C_k + 0.097C_u + 0.026C_{th}) \text{ (Rybach } et\ al.\text{, 1988)} \qquad (1a)$$

Where C_u, C_{th} and C_k are concentrations of uranium, thorium and potassium respectively, and ρ is the rock density. Each of the radioelement concentrations were multiplied by a numerical constant. These constants reflect the differing contributions to the RHP of each radioelement in μWm^{-3} of rocks per unit of potassium, uranium and thorium. The constant for uranium is 0.097 which is about two times the constants for potassium (0.035) and thorium (0.026) these

constants show that uranium play dominant role than thorium and potassium in radiogenic heat production.

The result of crustal radiogenic heat production (RHP) rate for the selected sections, was presented in tabular form showing the coordinate, concentration of ^{40}K, ^{238}U and ^{232}Th and RHP in (µ W / m^3). It has been established that the average radiogenic heat flow is 2.25 µ W / m^3 for granitic rock (Rybach 1981) value greater than this are anomalous which indicate feasibility of the geothermal energy.

Data acquisition and analysis

Ten (10) digital half degree HRAR colour maps each are having an area of 55 km x 55 km (sheet number 2 - 3, 9 – 10, 28 – 29, 49, 72, 95 and 117) on a scale of 1:100,000 with a total 2,748,653 data points were used in this work. The whole data, which were procured from the Nigerian Geological Survey Agency (NGSA) and assembled into total count map (Fig. 3), using a computer geophysical software Oasis Montaj version 6.4.2, the data range between 116979.90 and 5615.96 Cps with an average of 99489.16 Cps and a standard deviation of 41.212. The regions of pink to red indicates areas of high concentration of the three radioelements ^{40}K, ^{238}U and ^{232}Th while the blue region indicate areas of low concentration. This nationwide regional scale data (HRAR) has been processed and corrected by the NGSA before the eventual publication as HRAR colour Maps. The composite map was then analyzed into the content map of each of the radiogenic heat producing elements and 5,153 values of concentration were generated using Oasis Montaj Processing Software. Equation.2 was then used for calculating RHP from radioelement's concentration.

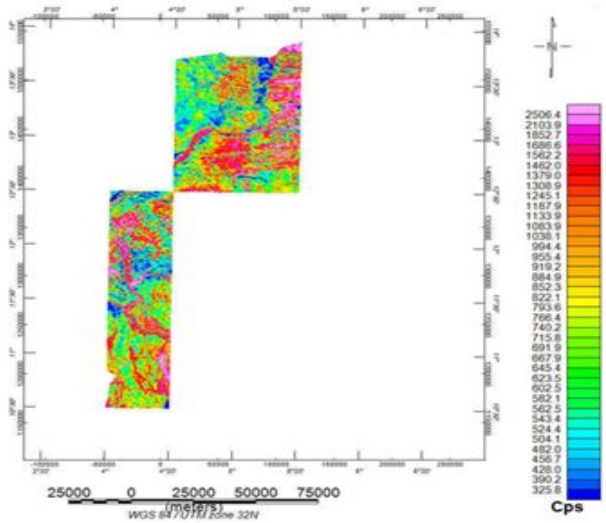

Fig. 3: Total Count Map of parts of Sokoto Basin

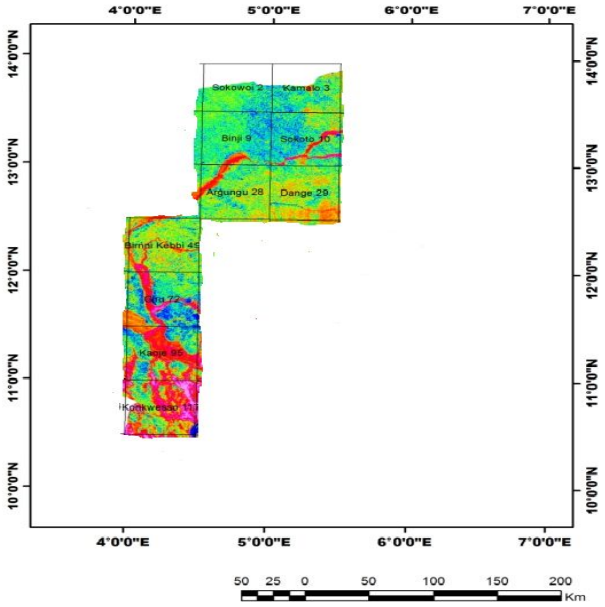

Fig. 4: Potassium concentration map of parts of Sokoto Basin

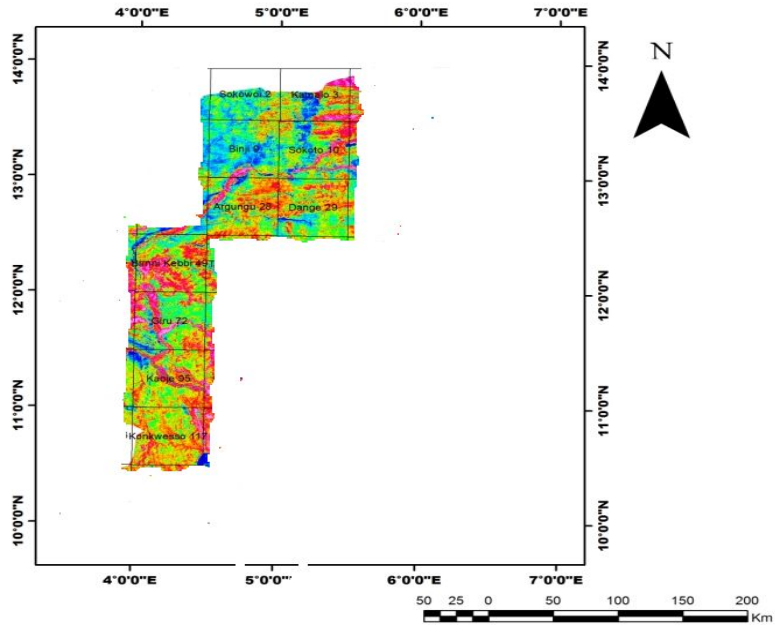

Fig. 5: Thorium concentration map of parts of Sokoto Basin

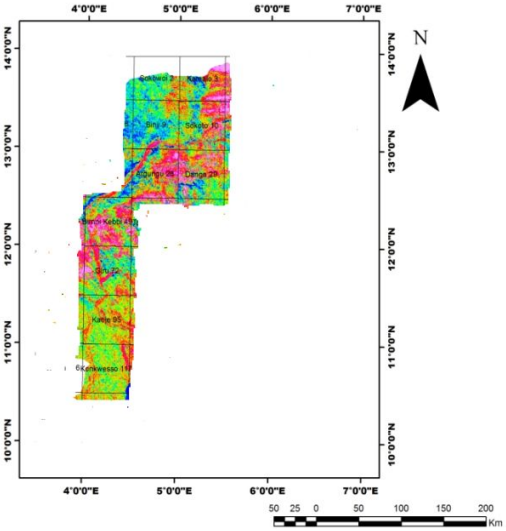

Fig. 6: Uranium concentration map of parts of Sokoto Basin

Radiogenic Heat Production (RHP) Estimation

The radiogenic near surface heat generated by heat producing elements from the radioactive decay in the earth's crust is calculated by summing the contribution of each radioactive element with the following formula (Rybach, 1988)

$H = 10^{-11} \rho (3.48C_k + 2.56C_{th} + 9.52C_u)$ (Rybach *et al.*, 1988) (1b)

In sokoto basin the average upper crustal density (ρ) is 2700 kgm^{-3} (Aku *et al.*, 2013), using a constant value for the upper crustal density will lead to overestimating the RHP of sedimentary bedding whose average density is approximately 20 % lower than that of crystalline rocks, this together with heat production constant (3.48, 2.56, and 9.52) was used to estimate RHP for each of the heat producing elements in the soil and rocks of the crust while A is total geothermal heat produced due to the three elements A(μWm^{-3}) was evaluated as:

$A = 0.094\ C_k + 0.069\ C_{th} + 0.257\ C_u$ (2)

Several different formulae have been adopted over the years in physics that account more precisely for the energy of the neutrinos with negligible difference ((<5%), but for the sake of consistency between data sets, we have used the standard values of the geophysicist and geologist. Table1 shows locations coordinate of points with highest RHP values of the total 5,153 values.

Table 1: Summary of radiogenic analyses and evaluated RHP parameters

Location	Long (^oE)	Lat (^oN)	K (%)	Th (ppm)	U (ppm)	Potassium (μWm^{-3})	Thorium (μWm^{-3})	Uranium (μWm^{-3})	Total/RHP (μWm^{-3})
Sokwoi	4.90	13.57	0.101	9.419	3.507	0.010	0.650	0.901	1.56
Kalmalo	5.47	13.85	0.198	17.073	9.410	0.019	1.178	2.418	3.62
Binji	4.93	13.23	0.200	7.677	3.763	0.019	0.530	0.967	1.52
Sokoto	5.41	13.37	0.207	13.329	8.411	0.019	0.920	2.162	3.10
Argungu	4.91	12.71	0.309	10.874	7.935	0.029	0.750	2.039	2.82
Dange	5.18	12.71	0.360	15.084	17.134	0.034	1.041	4.403	5.48
BirninKebbi	4.25	12.24	0.176	13.396	6.862	0.017	0.924	1.764	2.70

Giru	4.25	12.00	0.199	15.019	6.277	0.019	1.036	1.613	2.67
Kaoje	4.25	11.48	1.077	14.157	3.709	0.101	0.977	0.953	2.03
Konkwesso	4.25	10.73	1.001	10.585	3.753	0.094	0.730	0.965	1.79

Results and Discussions

It has been established that the average radiogenic heat flow is 2.25 μWm^{-3} for younger sedimentary and granitic rocks (Rybach 1981), value greater than this are considered as radiometric anomalies indicating feasibility of geothermal potential that is purely crustal origin with no mantle input. Table 1, indicates selected areas with high RHP of 5,153 values too large to be published. Some of the areas with RHP anomalous correspond to areas that are lithologically consistent with limestone, granite and shale which are known to have the highest concentration of ^{40}K, ^{238}U and ^{232}Th are long lived isotopes of interest in radioactive decay in the earth's crust. The, Kalmalo, Sokoto, Argungu, Dange, Birni Kebbi and Giru has RHP anomalous values of 3.62 μWm^{-3} 3.10 μWm^{3}, 2.82 μWm^{-3} , 5.48 μWm^{-3}, 2.70 μWm^{-3}, 2.67 μWm^{-3}, respectively may be good areas for geothermal exploration and therefore are recommended for detailed ground-based radiometric survey and lab tests. The Sokwoi, Binji, Kaoje ,and Kwonkosso areas with low RHP values of 1.56 μWm^{-3}, 1.52 μWm^{-3} 2.03 μWm^{-3} and 1.79 μWm^{-3} may not be prospect areas for geothermal exploration. Figure 7 shows that the RHP contour map is trending NE – SW with the highest value of RHP in the northern part of the study areas while the southern parts characteristically have low RHP and hence low geothermal potential except for Birnin Kebbi and Giru which correspond to areas with occurrence of phosphate. The map shows a clear correlation with the geology of the area.

The results agree with Uwa (1984) and Ofor (2014). This study fills the gap of the lacking baseline geothermal data and avoids mistakes that have been previously made.

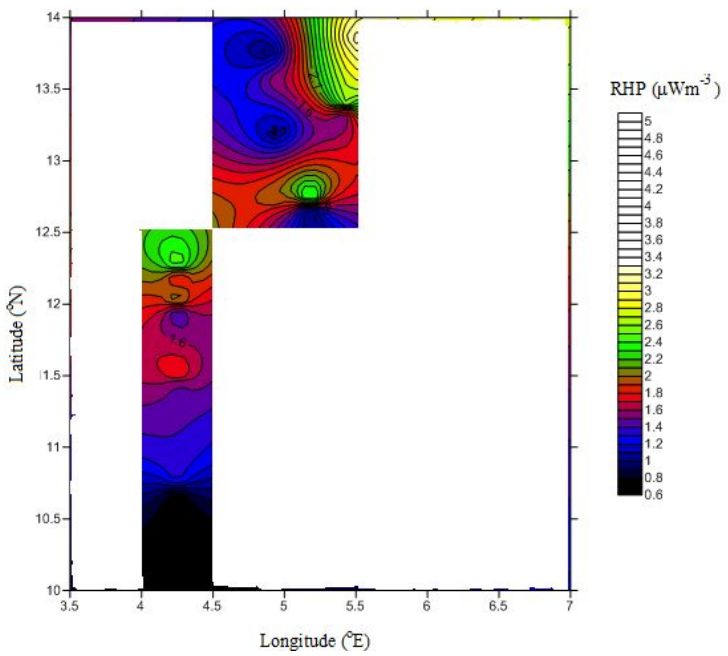

Fig. 7: Contour map of RHP of parts of Sokoto Basin (Contour interval 0.1 μWm^{-3})

Conclusions

The results show of crustal radiogenic heat production (RHP) rate for the selected sections ranges from 0.07 to 5.48 μWm^{-3} with an average of 1.07 μWm^{-3} for 5,153 values. Some of the areas with radiometric anomaly, are lithologically consistent with limestone, granite and shale which are known to have the highest concentration of ^{40}K, ^{238}U and ^{232}Th. Low RHP values are observed at Kaoje, Konkwosso, Sokwoi and Binji areas, may not be prospect areas for geothermal exploration. RHP results higher than Rybach average of 2.25 μWm^{-3} observed at Dange, Kalmalo, Sokoto, Argungu, , Birni Kebbi and Giru associated with highest heat production of ^{238}U in each value are suggestive of anomalous geothermal conditions may be good areas for geothermal exploration and therefore are recommended for detailed ground-based radiometric survey and Lab tests. ^{238}U is the major radioelement, which predominates in the geothermal energy potential parts of the study areas that can be tapped as an alternative to fossil fuel based energy in Nigeria.

Acknowledgments

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ARTICLES AND RESEARCH REPORTS ON TECHNOLOGY

MORINGA OLEIFERA: MEDICINAL VALUES, ANTIMICROBIAL PROPERTIES AND APPLICATION AS FOOD INGREDIENTS-A REVIEW

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Abstract
Moringa oleifera Lamarck is a native plant to the southern foothills of the Himalayan areas of Asian countries and currently grown in many tropical and subtropical countries. The plant parts are used in the preparation of herbal medicine for the treatment of diver's pains and diseases in South Asia. It is an important food source in some parts of the world such as India and Africa where it is used to combat malnutrition. The immature green pods, seeds, dried leaves and seed oil are used in food preparation. The interest in utilization of moringa seed as antimicrobial agents, medicinal uses, food additives and application in food preservation has been amplified in the past few decades by an increasingly negative consumer perception of most synthetic food preservatives and drugs. In addition, food-borne diseases are overwhelmingly increasing public health problem which calls for more effective preservation strategies. The nutritional composition, medicinal uses and antibacterial properties of the various parts of Moringa oleifera have been documented extensively. However, there is dearth's of information and limited knowledge about the mode of action of the plant extracts. This review encourages researchers to focus on methods of processing the parts into a more useful and acceptable food products, the mode of action of the individual chemical component or synergistic interactions of the chemical compounds of the plant on different microbial species, and on their reactions with food chemical matrix that will enhance its extracts to be used as food preservative.

Key words: *Moringa oleifera*, medicinal value, antimicrobial properties, food ingredients

Introduction
The plant *Moringa oleifera* Lamarck (M. ptreygosperma Gaertn.) is a naturalized species of a monogeneric family Moringaceae (Anwar *et al.*, 2007). The tree ranges in height from 5 to 10 m and distributed in many parts of Asia (Morton, 1991). According to Anwar *et al.* (2007), it grows in wild, cultivated in hedge, garden and back yards of the house. The plant grows well in tropical climate in the humid tropics or hot dry land and on loamy or sandy loam soil. Moringa grows and flower in less than a year. It survives low fertile soils and less affected by drought (Morton, 1991). The plant tolerates wide range of rainfall with minimum annual rainfall requirements estimated at 250 mm and maximum at over 3000 mm and pH of 5.0-9.0 (Palada & Chang, 2003). *Moringa oleifera* is native to the western and sub-Himalayan tracts, India, Pakistan, Asia Minor, Africa and Arabia (Anwar *et al.*, 2007). In some parts of the world, *M. oleifera* is referred to as 'drumstick' or 'horse radish' tree (Anwar *et al.*, 2007). In Pakistan, *M. oleifera* is known as '*Sohanjna*' (Anwar *et al.*, 2005; Anwar *et al.*, 2007). *Moringa oleifera* is an

important food substance with great attention as 'natural nutrition of the tropics and subtropics'. Every part of the plant such as leaves, fruit, flowers and immature pods are used as vegetable in many parts of the world, particularly in Asian countries and Africa (Anwar & Bhanger, 2003; Anwar *et al.*, 2005; Anwar *et al.*, 2007). Moringa leaf has been reported to be a rich source of nutrients like β-carotene, protein, ascorbic acid, calcium (4times more than milk), potassium; it acts as good source of natural antioxidants such as ascorbic acid, flavonoid, phenolic and carotenoid; thus enhances the shelf-life of food containing high quantity of fats (Dillard & German, 2000). Morimitsu *et al.* (2000) and Anwar *et al.* (2007) reiterated the facts that the parts such as root, bark, gum, leaf, fruit (pods), flowers, seed and seed oil have been used for treatment of various ailments in South Asia. Some of the parts have also be implicated in the treatment of inflammation and infectious diseases along with cardiovascular, gastrointestinal, haematological and hepatorenal disorders (Morimitsu *et al.*, 2000; Anwar *et al.*, 2007). Moringa seed has antipyretic properties, very bitter and show antimicrobial activity (Anwar *et al.*, 2007). Its seeds may be eaten raw or roasted and pound followed by pressing into high quality oil such as 'Ben oil. The unique property is the ability of its dry, crushable seed which may be pressed into cake. The cake contains polypeptide that serves as natural coagulants for water treatment (Ndabigengesere & Narasiah, 1998). Pioneering reviewers have elucidated some uses of the plant part in the treatment of some diseases as indicated in Table 1. Although, detailed knowledge about the mode of action of the plant constituent compounds is lacking, from literature search, there has not been a comprehensive review on the versatile utility of the antimicrobial activities of *Moringa oleifera* plant and its uses as food additives. This has persuaded us to create a viaduct for information flow among researchers and to give a comprehensive review of areas where researches has been conducted on *Moringa oleifera* plant.

Table 1: Overview of the medicinal uses of various parts of *Moringa oleifera* plant

Plant parts	Application	References
Leave	Treatment of fevers, sores and sore throat, bronchitis, ear and eye infections, scurvy and catarrh, pile and headaches.	Morton, 1991; Makonnen *et al.*,1997; Anwar et al., 2007
Seed	Used as laxative, anti-stress, anti-menstrual pain, anti-diabetic antihypertensive, brain booster, improved vision, alleviates constipation and aids in sleeplessness or insomnia.	Faizi *et al*, 1998; Lalas and Tsaknis, 2002; Anwar *et al.*, 2007.
Flower	Used as stimulant, aphrodisiac, anti-inflammations and abortifacient. Treatment of tumour and prevention of enlargement of the spleen. Decreases lipid profiles such as cholesterol, phospholipids, and triglycerides. Increased discharge of faecal cholesterol in rat.	Bhattacharya *et al.*, 1982; Dahot, 1988; Mehta *et al.*, 2003; Anwar *et al.*, 2007.
Stem bark	Used for the treatment of diseases of the eye; prevention of spleen enlargement and formation of tubercles glands on the neck. Has effect on tumour cells and used for the treatment of ulcer. The juice from the root bark has anti-tubercular activity and has been used as pain killer for the treatment of ears and teeth.	Bhatnagar *et al.*, 1961; Anwar *et al.*, 2007.

Pod	Antihypertensive	Faizi *et al.*, 1998; Anwar *et al.*, 2007
Gum	Treatment of dental carries. The Gum could be mixed with sesame seed oil before used for the treatment of headache, fevers, intestinal pains, dysentery, asthma and rheumatism.	Anwar *et al.*, 2007
Root	Used for the following: anti-inflammatory, anti-constipation, anaesthetic, vesicant, carminative, anti-fertility, laxative, stimulant especially in paralytic conditions and possesses spasmodic activity.	Caceres *et al.*, 1992; Padmarao *et al.*, 1996; Ezeamuzle *et al.*, 1996; Anwar *et al.*, 2007.

Processing and extraction of *Moringa oleifera* plant parts

Different methods and solvents have been employed for processing and extraction of various parts of *Moringa oleifera* plant used in research studies. Moringa leaves have been dried-milled (Karim *et al.*, 2013), aqueous extracts of the leaves has been freeze dried (Chuang *et al.*, 2007), the seed oil has been extracted using 2% bacterial nutrase enzymes (Novozyme, Denmark) obtained from the bacteria '*Bacillus amyloliquefaciens*' (Abdulkarim *et al.*, 2005). Among the solvents that have been used for the extraction of moringa leaves and seeds are cold or hot water (Chuang *et al.*, 2007), methanol, hexane, ethanol and supercritical extraction with CO_2 (Ortiz-Palafox *et al.*, 2010), chloroform and petroleum ether (Abdulkarim *et al.*, 2005), hexane, butanol and ethyl acetate (Chuang *et al.*, 2007; Ortiz-Palafox *et al.*, 2010) or combination of two or more of the solvents at different ratio. Steam distillation has been used for the extraction of essential oil from the leaves (Chuang *et al.*, 2007). The seed was extracted consecutively three times with combinations of *n*-hexane, ethyl acetate and *n*-butanol followed by complete dryness under reduced pressure or freeze drying to obtain sub-fractions of seed extracts (Chuang *et al.*, 2007). In addition, Mani *et al.* (2007) had also extracted the oil of moringa seeds using n-hexane, petroleum spirit and acetone.

Chemical properties and medicinal value of *Moringa oleifera* extracts

Gilani *et al.* (1992) reported on the antispasmodic activity of the ethanol extract of *M. oleifera* leaves and attributed the presence of 4-[α-(L-rhamnosyloxy) benzyl]-o-methyl thiocarbamate, which forms the basis for its traditional use in treating diarrhoea. The leaf extracts in rats were found to regulate thyroid status and cholesterol levels (Tahiliani & Kar, 2000; Ghasi *et al.*, 2000). Many reports described *M. oleifera* as a highly potent anti-inflammatory (Ezeamuzle *et al.*, 1996), hepatoprotective (Pari & Kumar, 2002), anti-hypertensive (Faizi *et al.*, 1995) and anti-tumor (Murakami *et al.*, 1998).

The methanol fraction of *M. oleifera* leaf extract showed anti-ulcerogenic and hepatoprotective effects in rats (Pal *et al.*, 1995). Makonnen *et al.* (1997) considered moringa leaf as potential ingredients to be used as antitumor and anticancer. The authors affirmed that the compounds O-Ethyl-4-(α-L-rhamnosyloxy) benzyl carbamate, α-L-rhamnosyloxy-benzyl isothiocyanate, niazimicin and 3-O-(6′-O-oleoyl-β-D-glucopyranosyl)-β-sitosterol are implicated as potential antitumor promoting agents using an in vitro assay which showed significant inhibitory effects on Epstein-Barr virus-early antigen. Niazimicin has been proposed to be a potent chemo-preventive agent in chemical carcinogenesis (Guevara *et al.*, 1999). Aqueous leaf extracts also

showed antiulcer effect (Pal *et al*., 1995) indicating that the antiulcer component is widely distributed in this plant.

Chuang *et al*. (2007) reported a total of 44 compounds present in the essential oil of *Moringa oleifera* leaf and gave the major constituents as: pentacosane (17.41%), hexacosane (11.20%), E-phytol (7.66%) and 1-[2,3,6-trimethyl-phenyl]-2-butanone (3.44%).

Moringa oleifera flower contains nine amino acids, sucrose, D-glucose, alkaloids, wax, quercetin and kampferat (Ruckmani *et al*., 1998). Both the aqueous and alcohol extracts from moringa flowers were also found to have a significant hepatoprotective effect (Ruckmani *et al*., 1998), which may be due to the presence of quercetin, a well-known flavonoid with hepato-protective activity (Gilani *et al*., 1997). The seed oil has physical and chemical properties equivalent to that of olive oil and contains a large quantity of tocopherols (Tsaknis *et al*., 1999). In recent years, many people in Taiwan or China have been using the seed of moringa as herbal medicine to treat tinea and athlete's foot diseases and found that it is effective. The seed extracts are also found to be effective on hepatic carcinogen metabolizing enzymes, antioxidant parameters and skin papillomagenesis in mice (Bharali *et al*., 2003). The seed*s of Moringa oleifera* contain the compounds rhamnose, glucosinolates and isothiocyanates (Fahey *et al*., 2001; Bennett *et al*., 2003). The compound O-ethyl-4-(α-L-rhamnosyloxy) benzyl carbamate (Guevara *et al*., 1999) and seven other bioactive compounds namely 4(α-L-rhamnosyloxy)-benzyl isothiocyanate, niazimicin, 3-O-(6′-O-oleoyl-β-D-glucopyranosyl)-β-sitosterol, β-sitosterol-3-O-β-D-glucopyranoside, niazirin, β-sitosterol and glycerol-1-(9-octadecanoate) have been isolated from the ethanol extract of the Moringa seed (Anwar *et al*., 2007). Moringa roots have also been reported to possess hepatoprotective activity (Ruckmani *et al*., 1998). The bark was reported to contain the alkaloids moringine and moringinine (Anwar *et al*., 2007). The stem was also reported to contain the compounds vanillin, β-sitosterol, β-sitostenone, 4-hydroxymellin and octacosanoic acid (Faizi *et al*., 1994; Anwar *et al*., 2007). The purified gum exudate of *moringa* was found to contain L-arabinose, L-galactose, L-glucuronic acid and L-rhamnose, L-mannose and L-xylose, while the acid hydrolysed gum exudate consists of L-galactose, glucuronic acid and L-mannose (Bhattacharya *et al*., 1982). The ethanol extract of moringa pods yielded an antihypertensive compounds namely thiocarbamate and isothiocyanate glycosides (Faizi *et al*., 1998).

Antimicrobial activity of *Moringa oleifera* extracts

Das *et al*. (1957) and Rao *et al*. (2001) reported the presence of an active antibiotic principle called pterygospermin in the leaf and flower respectively. This active component of *Moringa oleifera* has powerful antibacterial and fungicidal effects (Ruckmani *et al*., 1998). The aglycone of deoxy-niazimicine (N-benzyl, S-ethyl thioformate) isolated from the chloroform fraction of an ethanol extract of the root bark was found to be responsible for the antibacterial and antifungal activities (Nikkon *et al*., 2003). The bark extract has been shown to possess antifungal activity (Bhatnagar *et al*., 1961), while the juice from the stem bark showed antibacterial effect against *Staphylococcus aureus* (Mehta *et al*., 2003). The fresh leaf juice was found to inhibit the growth of pathogenic microorganisms such as *Pseudomonas aeruginosa* and *Staphylococcus aureus* (Caceres *et al*., 1991). The root extract possesses antimicrobial activity attributed to the presence of 4-α-L-rhamnosyloxybenzyl isothiocyanate (Eilert *et al*., 1981). Caceres and Lopez (1991) reported the efficacy of the seed ointment of moringa when compared with neomycin; a synthetic antibacterial agent against *Staphylococcus aureus* in mice with pyodermia. Ethanol extracts showed anti-fungal activities in vitro against dermatophytes such as *Trichophyton*

rubrum, *Trichophyton mentagrophytes*, *Epidermophyton floccosum*, and *Microsporum canis* (Chuang *et al*., 2007). The authors showed that both crude and sub-fraction of the essential oil of the leaf and sub fractions of the seed extracts using different organic solvent such as ethanol, ethyl acetate, hexane and butanol have anti-fungal effect on *T. rubrum*, *T. mentagrophytes*, *E. floccosum* and *M. canis*. From their findings, the minimum inhibitory concentration (0.156 mg/ml) of the seed extract of ethyl acetate fraction showed the strongest anti-fungal activity against *M. canis.* However, both leaf crude extract and sub-fractions had little effect on dermatophytes (Chuang *et al*., 2007).

Application of *Moringa oleifera* food ingredients for man

The consumption of *Moringa oleifera* leaves is critical to the alleviation of worldwide nutritional deficiencies. In addition foods that are rich in antioxidant substances and micronutrients are strongly recommended for consumption by victims of AIDS or HIV. Yang *et al*. (2006) surveyed over 120 species of both tropical and subtropical edible vegetables for anti-nutrients, antioxidants and crop traits and concluded that *Moringa oleifera* is a promising crop that could contribute to the increased intake of micronutrients and antioxidants. Presently, *Moringa oleifera* plant has been included as part of the world Vegetable Centre (WVC) nutritional seed kit, which is distributed by the regional centres to farmers and extension workers (Yang *et al*., 2006). Yang *et al*. (2006) evaluated four species of moringa namely: *Moringa oleifera*, *Moringa stenopetala*, *Moringa peregrina* and *Moringa drouhardii* and comparatively reported highest nutritional composition in *Moringa oleifera*. The authors stressed the importance of harvest period and stage of development when leaves are harvested to have significantly influenced nutritional composition of moringa; for instance higher protein, vitamin A, glucosinates and antioxidant contents were obtained in hot-wet season, whereas, higher iron, vitamin C and phenolic were found in cool-dry season (Yang *et al*., 2006). Mature leaves were found to be more nutritious than young shoots, it also dries earlier with minimum loss in nutrients; however young shoots exhibited better eating quality and are better accepted for fresh market (Yang *et al*., 2006)

The nutritional quality of four different species of moringa were reported on wet matter basis by Yang *et al*. (2006) and among the four species; *Moringa oleifera* contained the highest amounts of protein (5.8), β-carotene (15mg/100g) and iron (9.2mg/100g). The antioxidant content of moringa is high compared with common vegetables and fruits. On dry matter basis, the antioxidant compositions of moringa varieties were given as follow: phenolic (74-210µmol/g), ascorbate (70-100 µmol/g), β-carotene (1.1-2.8µmol/g) and tocopherol (0.7-1.1µmol/g).

The seed of *Moringa oleifera* has been used to fortified yam flour for production of 'amala' a stable diet in the Western parts of Nigeria (Karim *et al*., 2013). There was no significant ($p<0.05$) difference among the samples for the sensory qualities of colour, mouldability and mouth feel at up to 8.0% inclusion level (Karim *et al*., 2013). The sample prepared from yam flour fortified with 2.5% *Moringa oleifera* leaf powder compared favourably well with the control sample (yam flour only) in all sensory attributes, proximate and mineral composition without affecting the overall acceptability (Karim *et al*., 2013). Moringa seeds contain between 30-42% oil consisting of saturated fats (13%) and unsaturated fatty acids (82%) which are important in human diets. Moringa oil known as Ben oil in Mexico has about 70 % oleic acid and possesses good oxidative stability. It is very good for frying when used alone or when mixed with other oils and also more stable than common oils extracted from canola, soybean, and palm trees. Blending Ben oil with sunflower oil and soybean oil enhance the oxidative stability of the

mixture (Abdulkarim *et al*., 2005). Mani *et al*. (2007) affirmed the edibility and high quality attributes of moringa oils when compared with edible olive oil.

Moringa seeds also contain phytochemicals with known powerful antioxidant ability such as kampferol, quercetin, caffeolyquinic acids, β-sitosterol, rutin, and zeatin. Oliveira *et al*. (1999) reported the nutritional composition of mature seeds of *Moringa oleifera* on dry matter basis as crude protein (33.25%), crude fat (41.20%), carbohydrate (21.12 %) and ash (4.43 %). The essential amino acid profiles compared favorably with the FAO/WHO/UNU scoring pattern requirements for human. However, the authors showed that the seed is deficient in some essential amino acids such as lysine, threonine and valine (Oliveira *et al*., 1999). They reiterated that the content of methionine + cysteine (43.6 g kg^{-1} protein) was exceptionally higher and close to that of milk (human and cow) and egg (chicken) (Oliveira *et al*., 1999). Feeding rats with a diet containing the seed meal showed loss of appetite, retarded growth and increased weight of some parts such as the stomach, intestine, liver, pancreas, kidney, heart and lung when compared with rats fed on an egg-white diet. The authors suggested suitable processing methods as a means of abolishing the yet unknown adverse factors in matured *Moringa oleifera* seeds if it must be used as food ingredients in human diet (Oliveira *et al*., 1999).

Conclusion

Many scientists have conducted different studies on different parts of *Moringa oleifera* plant. Food plants are considered very safe for human consumption especially if properly processed and well preserved; as it is believed to have synergistic effects and combinations of neutralizing activities in humans. It is worthwhile, to conduct research on the positive impacts and neutralizing side-effects of the different parts of *Moringa oleifera* plant in human, animal and diversity of microbial species.

From various studies over a decade, *Moringa oleifera* leaves have been reported to contain high quantity protein source which has been recommended to combat protein shortage in the world especially in Africa. However, it is imperative to assess the quality of protein in various parts of moringa, especially the seeds and leaves to determine whether it could compete favourably in bioavailability with more common animal proteins.

Many studies have been carried out on performance using animal models. Broilers, piglets and other animal species have been fed *Moringa oleifera* leaves or seeds at different inclusion levels. Many studies have reported the antimicrobial activities of *Moringa oleifera* extract on different microbial species. However, reports on antimicrobial effects of essential oils, purified lipid and protein from *Moringa oleifera* leaves and seeds are rarely found; as such researchers should focus on the isolation and purification of moringa's important components which may in turns be used as antimicrobial agents or basis to formulate substances potent enough to combat some epidemics and diseases. It is imperative to conduct researches that would monitor the mode of action of the extracts obtained from different parts of moringa on different microbial species. Since these plant species naturally grow in different habitats, there may not be great differences in qualitative and quantitative chemical compositions of *Moringa oleifera* tree planted in various regions of the world. However, the extent to which the chemical composition varies in region where the tree are grown is yet unknown and should be investigated. Since the seeds and leaves are been used as food ingredients studies should also be conducted on the extracts reaction with food chemical matrix.

Finally, considering the multi-purpose applications of this important plant species, it could be suggested that government, private and individuals should be engaged in massive cultivation of the plant in countries where climatic conditions would favours its growth. In this process, there could be maximum production of the plant that could be processed into different food products and medicinal substances that can be used for the benefits of mankind.

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PREDICTION OF SLAG FORMATION DURING COAL COMBUSTION USING FACTSAGE EQUILIBRIUM MODELLING

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Abstract

In this paper, a thermo-dynamic model (based on FACTSage) has been used to predict the slag behaviour of coals under the high temperature conditions existing in the pf boilers. The viscosity of the slags has been calculated based on the amount and composition of the predicted molten phase and compared with the experimental data derived from entrained flow reactor (EFR). The nature of the deposits collected varies from completely molten, strong to weak deposit depending on the probe location in the EFR. The results of the slag viscosities obtained at specific temperatures between 1300 ^{o}C and 1250 ^{o}C fall within the region that corresponds to the probe 2 where sintered deposits were collected from the EFR. The Factsage calculation also revealed that this region corresponds to the region where the percentage of iron and calcium in the slag liquid reached its peak. The results revealed that the abundance of melted ash particles are dominant factors can be used to assess the strength of deposits.

Keywords: Coal; EFR; FactSage; Viscosity; Slag

Introduction

The coal ash contains significant proportion of mineral and inorganic components that lead to slagging and fouling deposits in boilers. Uncontrolled and/or unexpected formation of ash deposits on the heat transfer surfaces in a boiler can interfere with operation and reduce output or efficiency. With reduces furnace heat absorption capacity, increase furnace temperature elsewhere where may cause intensive slagging. These factors affect the overall performance of the plant including electricity production capability, equipment failure rate and hence the power generation cost (Wigley & Williamson, 1998).

Slagging refers to ash deposition in the furnace region of the boiler where heat transferred is exposed to radiant heat. The ash deposit is commonly molten and composed of highly fused particles. Another form of slagging is sintered deposit which is composed of partially fused particles. Slag may be homogenous or heterogeneous depending on factors such as the concentrations of dissolved inorganic elements, the rate of crystallization of inorganic species and the cooling rate of the liquid (Kondratiev and Jak, 2001). In a coal-fired power station, the sintered deposits can become very hard and difficult to remove by sootblowing. The strength of the deposit may be more important than the rate of deposition to an operator. The degree of sintering and hence the strength of the deposit is dependent on the chemical and mineralogical composition of the fly ash particles, the particle temperature, the surface temperature of the deposit and the gas temperature. The most widely used methods for characterizing coal ash deposition and slagging are ash fusion temperature (AFT), ash particle viscosity and ash chemistry (McLennen, Bryant, W. Bailey, Stanmore & Wall, 2000). The AFT, which determines the temperature at which the various stages of the ash deformation and flow takes place, is based on the judgment of the analyst as to when the ash reaches and passes through the

defined stages of the deformation. Since the assessment of this method is considered more empirical and subjective in nature and the results obtained may be unreliable.

The abundance of slag-liquid and viscosity of the slag-liquid are the key components requires for the deposit growth and sintering (Raask, 1985). The stickiness of liquid phase has been quantified, as suggested by many publications on the mathematical modelling of slagging. When the temperature of the particle is higher than the softening temperature the particle will sticks to the heat transfer surface otherwise it is rebounded (Mao, Kuhn & Tran, 1997). On this basis another concept of sticking probability was developed based on the melting curve of alkali-rich and silica-rich particles. In the work of Kaer et al. (Kaer, 2001), it has been assumed that the mass of the molten phase is non-sticky if the mass of the molten phase is below 15 %. Between 15 and 70 %, the mass of the molten phase is assumed to be sticky. Above this percentage, the mass of the molten phase is assumed to be flowing.

Although sintering processes can occur by vapour transport, surface diffusion, volume diffusion and viscous flow (Watt, 1969), the mechanism of viscous flow sintering appears to be the dominant mechanism responsible in creating silicate-based melts in the ash (Płaza, Ferens, Griffiths, Syred & W, 2003). The viscosity of liquid phase present in ash deposit is inversely proportional to the rate of sintering them and will decrease rapidly at elevated temperature. In the work of Raask et al. (1985) viscosities in the range of 10^7-10^{11} Pa*s resulted in the formation of significant sintered deposits in coal-fired boilers. A high viscosity implies a weak deposit where initial deposits are formed on clean boiler tube and the degree of sintering is low. With increasing temperature of the outer deposit surface, the ash viscosity decreases (more liquid) and sintering process become more important. The rate of the process increases with the temperature and the molten liquid (highly viscous) may eventually run down the deposition probe surface. Therefore, the developments of deposit strength depend on different temperature regimes as listed in Table 1.

Table 1: Viscosity scale for typical bituminous coal ash (Raask, 1985)

Event	Viscosity range (log10Pa *s)	Temperature (^oC)
Onset of sintering	9-11	930-1030
Medium-rate sintering	7-9	1030-1130
Rapid sintering	5-7	1130-1280
Formation of nonflowing slag	3-5	1280-1380
Slag flow due to gravity	2-5	1380-1430
Slag flow	0-2	>1430

Numerical prediction of ash deposition is used to advance the understanding of the underlying processes that lead to deposit formation, and it is considered as a powerful tool for the design and optimization of the operating parameters. Several attempts have been made to accurately predict the slagging behaviour of solid fuels in boiler situations. Slagging and fouling indices derived from the ash composition are simple models used to predict the ash behaviour in advance before the actual plant operation. The most commonly applied index is the basic-to-acid (B/A) ratio. Increasing the B/A of the coal decreases its fusibility and hence increases the slagging potential. Coals having B/A ≥ 0.11 are considered as bad coals (Lawrence, Kumar, Nandakumar & Narayanan, 2008). There are many similar indices to describe ash behaviour. However, it is difficult to extrapolate a specific value from one type of coal to another type of

coal, since slagging is also high dependent on the fuel type, local conditions, boiler geometry and operating conditions.

The second class of models used to assess the melting behaviour of coal ash slag are thermodynamic calculations. The most popular models of ash deposition are CFD-based models which combine deposition models with the complex flow patterns of a typical boiler. A two-dimensional model by Huang et al. (Huang, Norman, Pourkashanian & Williams, 1996) related to a deposition model to boiler condition in a pulverized coal combustor. The model assumption is that an impact involving any viscosity below a critical value results in the particle sticking. For viscosities lower than the critical viscosity, the sticking probability equals unity. Obviously, the choice of critical viscosity greatly affects the sticking probability of any particles on the deposition surfaces. The value of critical viscosity has been a topic of much discussion and various workers have proposed different value to describe the results obtained from experimental investigations. While Walsh et al. (Walsh, Sayre, Loehden, Monroe, Beer & Sarofim, 1990) used a value of 10^8 Pa-s, Srinivasachar et al. (1990) suggested that the critical viscosity is between 10^4 and 10^8 Pa-s for that for some US bituminous coals. Although the CFD-based models of ash deposition provide detailed local analysis of the flow, it has not been proven to be very successful in chemical thermodynamic calculation of oxide systems (commonly referred to as slags) which is significant in coal combustion.

In the last decade, an improvement in computational methods has made it possible to perform chemical thermodynamic calculations of oxide systems. One of the predictive tools used successfully in chemical thermodynamic model of oxide systems is the computer package FactSage^{TM} (Bale, 2009). FactSage is used worldwide in various industries to predict chemical equilibria, the proportions of liquid and solid phases as a function of temperature, composition and atmospheric conditions. One of the strengths of FactSage is its ability to describe the melting behaviour of the coal ash slag systems.

Since a good theoretical estimation of melting behaviour would require use of multiphase, multicomponent equilibrium calculations. In this paper a thermo-equilibrium calculation for a combustion process is applied to develop reliable models for predicting melting behaviour of slags which will then allow the assessment strength of deposits. The aim of this paper is to predict the viscosity of the actual slag by combining viscosity model with the equilibrium calculation. The organisation of the paper follows. Section 3 described the experimental investigation from the Imperial College EFR for the ash deposition and sintering of the coal combustion (Huang, Norman, Pourkashanian & Williams, 1996). In section 4, the results of the model predictions are presented and discussed together with relevant experimental data.

Methodology

In order to investigate ash sintering tendency, the following prediction methods have been used in this study: (i) thermodynamic equilibrium calculations, (ii) viscosity calculations. Fact Sage 6.2 (Bale, 2009) for the prediction of chemical equilibria through Gibbs energy minimization is a powerful tools in studying the chemistry of processes involving all molten salts, oxides, aqueous solutions, and gases. FactSage^{TM} was introduced in 2001 and is the combination of FactWin and ChemSage-two well-known models in the area of computational thermochemistry. The software packages consist of a series of database and manipulation modules that enable the users to perform a wide variety of thermochemical calculations, including those of multiphase computations.

When the elementary compositions of the fuel and air, pressure and temperature have been introduced and a slag type is selected from the default list of slags, FactSage will search the thermodynamic database for the species including all the elements in the slag type selected. It is thus possible to determine the quantity as well as quality of the gas phase, liquid phase and solid phase. In this investigation, FactSlage A-type is selected (containing 1144 species - 278 gas, 173 liquid, and 693 solid species). These species include the elements C, H, O, N, S, Cl, Si, P, Ca, K, Na, Mg, Al, Fe, Ti, and Mn. The physical and chemical properties of coal and biomass composition are presented in Table 1. The temperature range considered was from 1200–1600 °C with a step of 100 °C. 1000 kg fuel is used as a basis for the equilibrium calculation. The FactSage database contains more than 300 gaseous, liquid, and solid phases, including salt melt and mineral melt; however, this investigation only looked at the slag liquid, slag liquid composition and solid phase that are stable at the designated temperature range.

The slag-liquid comprises SiO_2, Al_2O_3, FeO, CaO, K_2O, Na_2O, MgO, MnO and TiO while the solid phase includes mullite ($Al_6Si_2O_{13}$(s)), tridymite (SiO_2(s)), leucite ($KAlSi_2O_6$(s)), cordierite ($Mg_2Al_4Si5O_{18}$(s)), hematite (Fe_2O_3(s)), anorthite ($CaAl_2Si2O_8$(s)), forsterite (Mg_2SiO_4(s)) and spinel ($MgAl_2O_4$(s)). This type of calculation has some limitations. The equilibrium calculations are based on the assumptions that all reactant are well mixed (homogeneous) and kinetic limitations are not taken into account. It must be stressed that FactSage only predict evaporative transport routes for the element and species, and do not take into consideration of the effects of particle entrainment, which are significant in combustion (van Dyk, Waanders , Benson, Laumb & Hack, 2009).

Source of Experimental data

The Entrained Flow Reactor (EFR) was designed to closely simulate the conditions which pulverize and ash particles experience in large-scale furnace (see Figure 1).The measurement techniques employed and the data obtained were reported in (Manton, Williamson and Riley, 1997; Wigley, Williamson, Malmgren and Riley, 2007) and these are summarized as follows. The reactor consists of four independently electrically heated furnaces, approximately 5 m long vertical tube with a diameter 100 mm. These furnaces provide a temperature gradient from 1650 ^oC at the top to 1200 ^oC at the bottom. A series of joints between each furnace accommodates the probes which allows the ash and char particles to be withdrawn from the combustion atmosphere. The gas temperatures at the ports 1, 2 and 3 are approximately 1400 ^oC and 1200 ^oC, respectively. Uncooled ceramic probes have been used to collect the ash deposits. The burner section consists of the primary inlet through which the primary air and the pulverized coal are fed, and the secondary air inlet, for the hot swirling air.

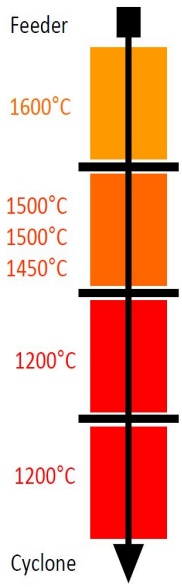

Figure 1: Schematic diagram of the Imperial College EFR (Wigley, Williamson, Malmgren & Riley, 20007)

Two typical bituminous UK power station coals (Russian and South African) were chosen as they are similar in composition, but behave differently when fired in an EFR, see Table 2. The fuel samples studied were dried, milled and sieved so that their diameters were less than 100 µm. The samples were then blended and dried at 120 °C in nitrogen gas prior to use. 100 g of fuel mixture was run for duration of 30 min, and the deposit sample was collected on probe 2 which is located in the midsection of the EFR. The probe has thermocouples that register the surface temperature of the deposits.

The ash deposits collected on the probes were then coated in a low viscosity epoxy resin, which penetrates the open porosity of the sample, and this gives stability to the deposits. Sections through the deposits were then cut to reveal a cross section. Two cross-sections were mounted in resin blocks and the samples were ground and polished for sintering analysis in a Scanning Electron Microscope (SEM). The cross-section through ash deposit containing the sinter ash and crystalline materials is shown in Figure 2.

The deposits collected at probe 1 (1500°C) were all of highly fused nature, with the most fused deposits flowing around the probe while the deposits collected at probe 1 (1200°C) were of lightly sintered nature, with distinctively visual differences in the degree of fusion. The ash deposits collected on the probes 1 and 2 were then coated in a low viscosity epoxy resin, which penetrates the open porosity of the sample, and this gives stability to the deposits. Sections through the deposits were then cut to reveal a cross section. Two cross-sections were mounted in resin blocks and the samples were ground and polished for sintering analysis in a Scanning Electron Microscope (SEM). The microstructures of the deposit from different deposition probes were compared (Wigley & Williamson, 1998).

Table 2: Coal and biomass ash content (wt %) and chemical composition (wt %) (Wigley, Williamson, Malmgren and Riley, 2007; Phyllis, 2004)

Component	R. coal	S. coal		R. coal	S. coal
Proximate analysis	Wt % on dry basis		Ash composition	Wt % on dry basis	
Volatiles	30	Al_2O_3	SiO_2	60.1	54.1
Fixed carbon	76	Fe_2O_3	Al_2O_3	24.0	33.5
Moisture	5.56	CaO	Fe_2O_3	6.0	3.1
Ash	12.6	MgO	CaO	4.1	4.1
CV(MJ/kg)	27	K_2O	MgO	1.1	1.3
Ultimate analysis	Wt % on dry basis		K_2O	3.0	0.7
C	76.5	TiO_2	Na_2O	0.4	0.1
H	4.5	MnO	TiO_2	1.2	1.7
O	4.9	P_2O_5	MnO	0.1	0.0
N	1.9	1.78	P_2O_5	0.0	1.4
S	0.4	0.83			
Cl	0.25	0.00			

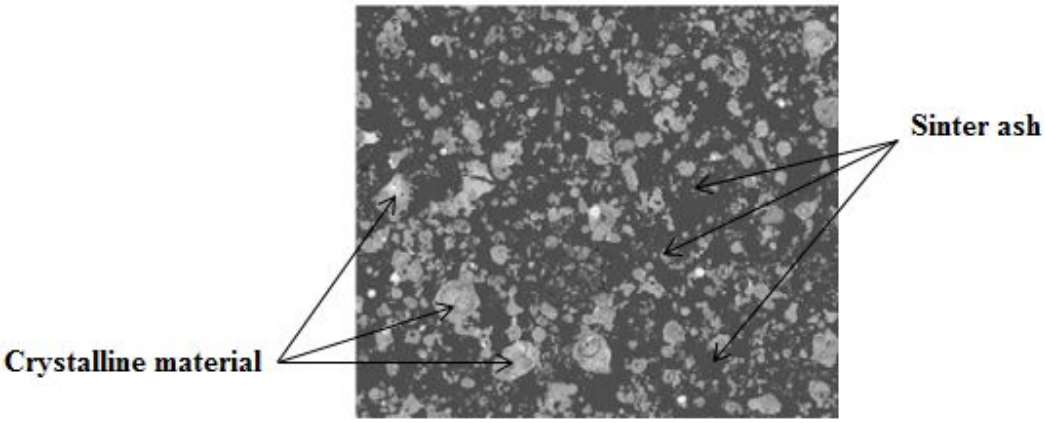

Figure 2: Cross-section through ash deposit containing the sinter ash and crystalline materials (Wigley, Williamson, Malmgren & Riley, 2007)

Results and Discussion

Substantial liquid formation requires higher temperatures: for the South Africa and the Russian coals shown in Figure 3, approximately 60% liquid is predicted at 1500 ^{o}C. Also, the extent of liquid formation depends on the fuel ash. The larger amount of slag liquid for the Russian coal in the temperature range of 1300 to 1600 ^{o}C may be attributed to the high Fe_2O_3 content which is greater than the sum of CaO and MgO in the fuel ash. Conversely, the low slag liquid predicted in Figure 3 is due to the fact that Fe_2O_3 content in South Africa coal is less than the sum of CaO and MgO in the fuel ash. The slag obtained depends on the gas temperature at the sampling port of EFR as this will directly affect the degree of assimilation of the iron phases into the aluminosilicate melt. Previous research, such as McLennen et al. (McLennen, Bryant, Bailey, Stanmore and Wall, 2000) has shown that the higher content of divalent iron in reduced conditions promote the formation of the molten phase.

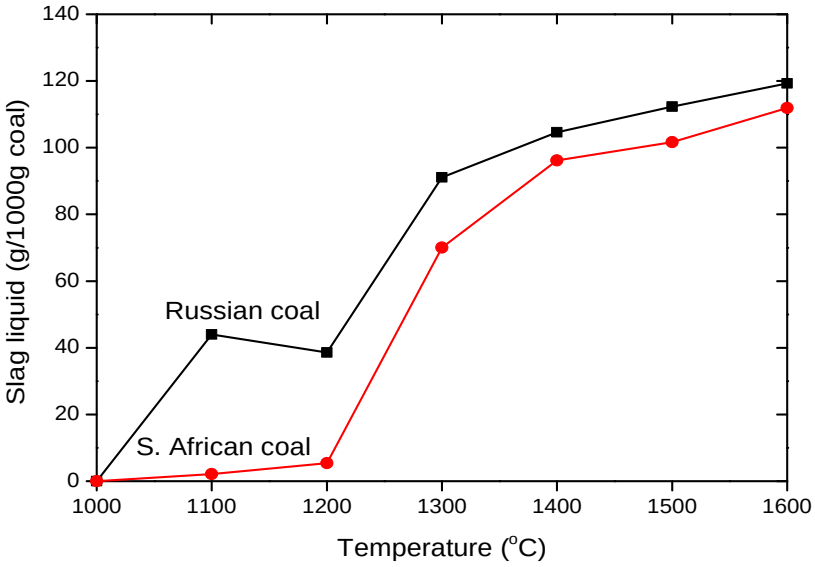

Figure 3: Mineral matter output from the Russian and South African coal combustion at different temperatures

The FactSage results show that mullite ($Al_6Si_2O_{13}$) is the main solid phase in South Africa coal as shown Figure 4, and this persists at 1600 °C. In contrast, the main solid in the Russian coal ash is tridymite (SiO_2), see Figure 5. From the ash content and chemical composition of the coals in Table 1, it is observed that Russian coal has high SiO_2 (60.1 wt.%) and low Al_2O_3 (24 wt.%) while South Africa coal has SiO_2 (54.1 wt.%) and high Al_2O_3 (33.5 wt.%) in the ash. The difference in the identity of the primary solid phase results from the differences in the composition of the ash: higher SiO_2 in the fuel ash favours tridymite formation, while higher Al_2O_3 levels favour mullite formation. Leucite ($KAlSi_2O_6$), anorthite ($CaAl_2Si_2O_8$) and mullite ($Al_6Si_2O_{13}$) are formed because of the interaction between of quartz with Al_2O_3 and CaO at about 1000 °C. Hematite (Fe_2O_3) and leucite ($KAlSi_2O_6$) appear at about 1400 °C but leucite ($KAlSi_2O_6$) which has a significant effect on the fusion characteristics rises sharply and remain fairly constant at 1230 °C. The slag disappears at 1000 °C for both the South Africa and Russian coals. In Russian coal, potassium silicate is characterized by large variations probably due to the periodic formation and dissolution of crystals in the melt (see Figure 5). The high amount of calcium, iron and potassium lead to the formation of Ca- , K- and Fe- silicates that are crystallized even at 1500° C. This may simplify the operation of the EFR because the ash will be relatively non-sticky.

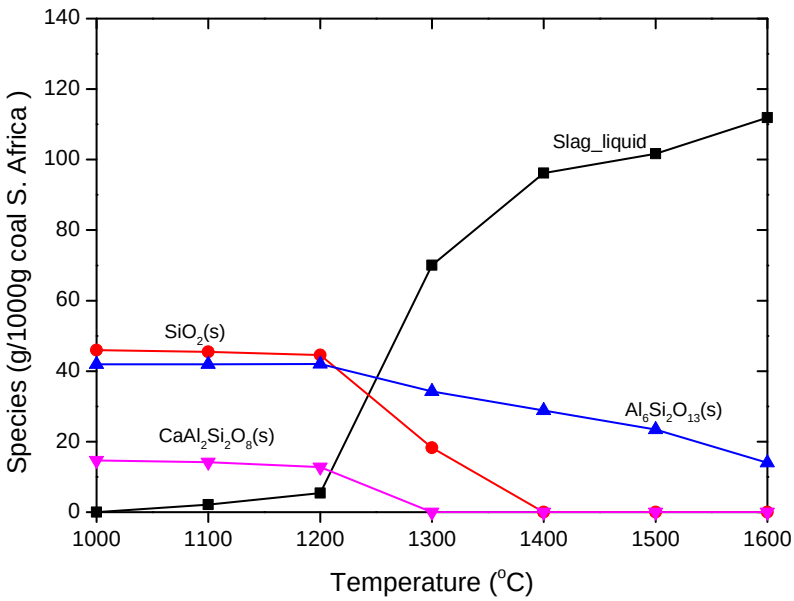

Figure 4: Mineral matter output from the South African coal combustion at different temperatures

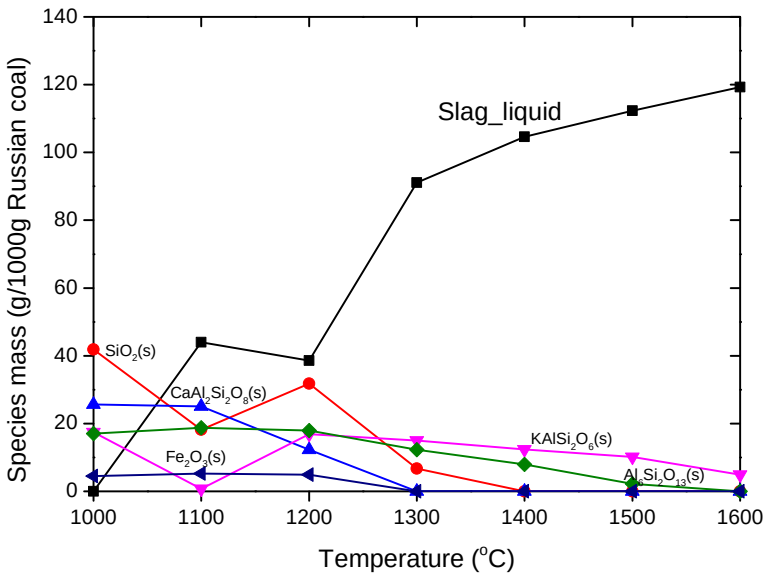

Figure 5: Mineral matter output from the Russian coal combustion at different temperatures

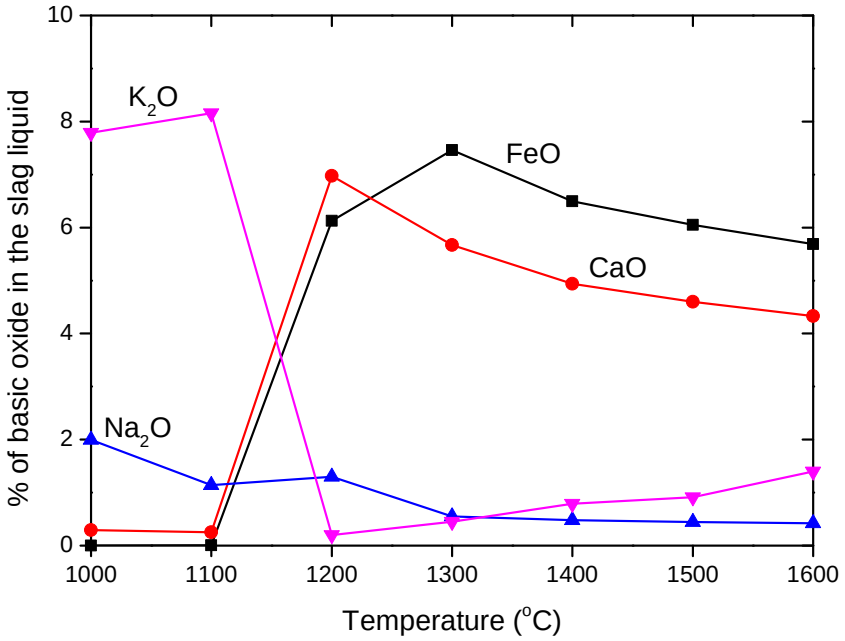

Figure 6: % of basic oxide in the slag liquid for Russian coal combustion at different temperature

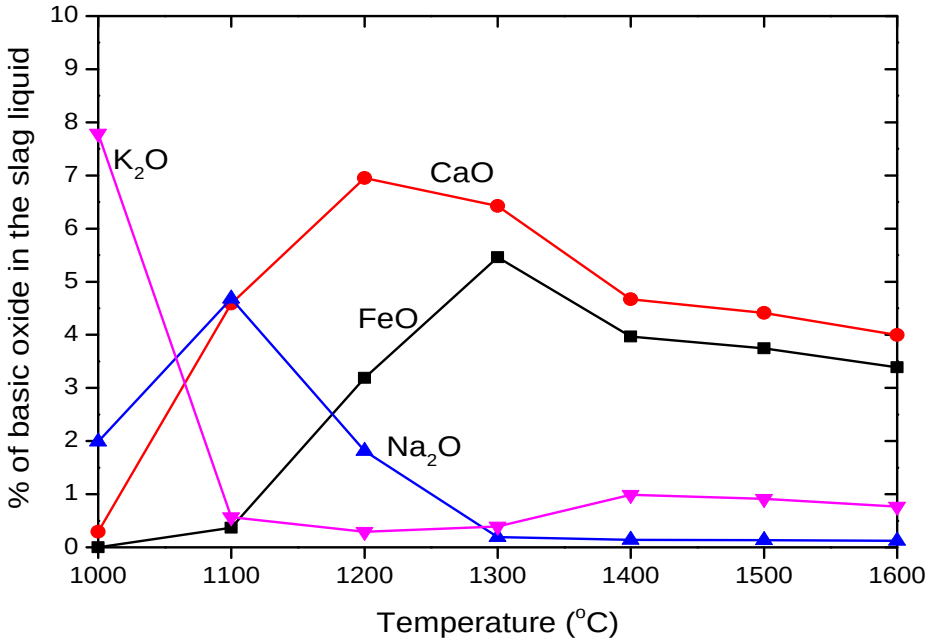

Figure 7: % of basic oxide in the slag liquid for South African coal combustion at different temperature

It can be observed from the results presented in Figures 4 and 5 that mullite ($Al_6Si_2O_{13}$) and tridymite (SiO_2) are higher in Russian coal in comparison with South African coal and this has been reported Oh, Brookerb, de Pazb, Brady and Deckerb, 1995) to increases the particle-to-particle bonding and act as a strong bridge between these particles. As the concentrations of oxide in the slag increases, the solubility limit is reached and metallic oxide will form solid from the slag as shown in Figures 4 and 5. Alternatively, unassimilated oxides may simply occur as crystalline within the glass matrix if either of this process occur, the presence of crystalline phases will increase the viscosity and inhibit sintering. Figure 6 and 7 shows the percentage of basic oxides in the slag liquid for Russian coal and South Africa coal respectively. The percentage of iron and calcium increased significantly when the combustion temperature is in excess of 1100 ^oC while potassium and sodium increased when the combustion temperature is less that 1100 ^oC. As the iron and calcium concentration of aluminosilicate glass increases, up to a certain level, the viscosity will tend to decrease and the rate of deposit sintering is enhanced. However, at higher concentration of oxides in the slag, the solubility limit of such oxide is reached and oxide crystallised out in form of mullite, tridymite, leucite, cordierite, hematite, anorthite, forsterite and spinel (see Figure 6 and 7).

Conclusion

The nature of the deposits collected varies from completely molten, strong to weak deposit depending on the probe location in the EFR. The results of the slag viscosities obtained at specific temperatures between 1300 ^oC and 1250 ^oC fall within the region that corresponds to the probe 2 where sintered deposits were collected from the EFR. The Factsage calculation also revealed that this region corresponds to the region where the percentage of iron and calcium in the slag liquid reached its peak. Moderate temperature ash deposits are most prevalent when iron and other fluxing agents are present in the ashes. In order for ash particle to become sintered, it must be sticky enough to stay in place on vertical surfaces, then harden sufficiently as the deposit grows to prevent shedding, erosion, or breakage from gas pressure and particle erosion. The model successfully predicts the viscosity of the slag and trend of decreasing in viscosity with increasing slag formation.

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EFFECT OF MICRO FINANCE BANK LOAN ON FARMERS OUTPUT IN KWARA SOUTH, NIGERIA

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Abstract

*Against the background of the recent recapitalization of the commercial banks in Nigeria which led to the restructure of community banks to microfinance bank this paper examine the effect of microfinance bank loan and social capital on farmers output of MFB beneficiaries in Kwara South, Nigeria. Data were collected in 2012 using a three stage sampling techniques which include purposive selected two local government, random selected 7 cooperative groups benefiting from MFB loan and randomly selected 10 farming household from each of the cooperative groups making a total of seventy respondents. The data were analyzed using descriptive statistics, gross margin analysis and a multiple regression model. It was found that total gross margin of the farm production on the average was ₦19,407.32 (US $ 97.40) per month. MFB loan, Cooperative loan, Gift and Mutual help are the major socio capital factors influencing the naira value of the output of MFB farmer beneficiaries (Fcal 16.031***, P.value<0.010). However, it was recommended that proper supervision should be given to disbursed MFB loan and that government should help MFB farmer beneficiaries to remove the production constraints and inadequate fund, by putting in place good policy towards empowerment of MFBs in rural area.*

Keywords: Recapitalization, Commercial bank, Restructure, Microfinance bank, Loan, Social capital, Beneficiaries, Mutual help, Gross margin, Multiple regression, Kwara South, Nigeria

Introduction

Agriculture has contributed immensely to the Nigeria economy in various ways, amongst which are; provision of food for the increasing population, supply of adequate raw materials and labour input to a growing industrial sector, source of employment, generation of foreign exchange earnings, and provision of market for the products of industrial sector (Okumadewa, 2009; World bank, 1998; FAO, 2006). It was noted that agriculture contributed 41.72%, 42.20%, 42.13%, 43.10%, 43.30%, and 43.59% of the Nigeria GDP in 2006, 2007, 2008, 2009, 2010, and 2011 respectively (CBN, 2005; 2007; 2010, NBS, 2011). However, sustainable agricultural development is necessary to ensure survival of the rapidly growing population of Nigeria, as well as the economic development of the country. In lieu of this, Nigeria agricultural policy provides among others, adequate financing for agriculture. The role of finance or credit in agriculture, just like in the industrial and service sector, cannot be over-emphasised. Public expenditure on agriculture has, however, not substantial enough to meet the objective of the government agricultural policy to bring about the growth and development of agricultural sector (International Food Policy Research Institute, 2008).

However, the government have deemed it fit to restructure the MFB in Nigeria through the process of recapitalization in order to be able to empower the small scale business including

agriculture through MFB loan. The application of microfinance systems has become a crucial factor in finance economics related discipline to the extent that local and international organizations are exploring the modalities of driving the best in the area of social economics needs of individual, small and medium enterprises over the years (Oloyombo, 2010). Oloyombo and Ogundimu, (2006) noted that microfinance institution is now a growing phenomenon all over the world.

According to CBN (2008) microfinance loans granted to clients is increasing from 2007 to date and most of it goes to financing microenterprises in rural areas. Ketu, (2008) observed that microfinance banks have disbursed more than ₦800 million micro credits to over 13,000 farmers across the country to empower their productive capacities. About 60 percent of poor people in the country live in the rural areas and 80 percent of them are farmers and artisans (NBS, 2005). Microfinance banks have therefore been the main sources of funding to these less disadvantaged groups. Rural people are empowered through microfinance loans and services, and hence small scale agricultural practice and microenterprise is developed.

Moreover, social capital represents social connections and all the benefits they generate (World Bank, 2006) which is also known to have contributed to the sustainability of the economic growth. The benefits for people having these social connections can occur either at an individual level (for example, through family support) or at a wider collective level. Hence, in measuring social capital through monetary valuation of social capital stocks approach consists of producing estimates of the value of social capital assets. The social capital identified in this paper aims to cover all the relevant dimensions of social capital which were personal relationships and social network support as identified by the OECD (OECD, Scrivens & Smith, 2013). Despite the numerous works on roles of microfinance banks, less is known about the effect of loan from micro finance banks and on farmers' output as well as the effect of social capital on the output of farmers in the area. Hence, the general objective of the study is to examine the effect of micro finance bank loan and social capital on farmers output of MFB beneficiaries in Kwara south, Nigeria. The specific objectives are to; identify the socio economic characteristics of the farmers, determine the gross margin of the MFB farmer beneficiaries in the study area, examine the effect of loan given by microfinance banks on the productivity of the farming households in the study area, and examine the challenges facing the farming household in accessing loan from micro finance bank in the study area.

Methodology

Study Area: This study was conducted in Kwara State Nigeria. The State was created on 27th May, 1976 and is usually referred to as the gateway between the northern and southern part of Nigeria. It lies on latitude 7^0 $15^{|}$N and longitude 6^0 $18^{|}$E and covers a land area of about 32500km^2. The State shares common boundaries with Oyo, Ondo, Osun, Niger and Kogi States and has an international border with the Republic of Benin (Kwara State Ministry of Information 2011). There are twenty three (23) Microfinance banks in Kwara State and has about 260,528 farm families (KWADP, 2006) and about 36,820 hectares of farmland (FOS, 1995).

Sampling/Data collection: A three stage sampling techniques was used. The first stage was the purposive sample of Isin and Irepodun Local Government Area (LGA) because majority of MFB's loan beneficiaries in this area were farmers, in the second sample stage 7 agricultural cooperative societies benefiting from loan from MFBs using Bank list of beneficiaries were randomly selected while the third stage involved the random selection of 10 farming household

respondents from the list of each of the agricultural cooperative societies making a total of 70 respondents. Data were collected through the use of structured questionnaire coupled with interview scheduled.

Data analysis

Descriptive statistics as well as inferential statistics were used to analyse the data obtained. Descriptive statistics such as percentage, frequency distribution, mean, and mode were used to analyze the socio – economic characteristics of the respondent. Gross margin analysis was used to determine the profitability of the MFB farmer beneficiaries while regression model was used to measure the effect of the incentives received by the respondents from MFB on their output. The incentives received by the respondents from the MFBs and cooperatives are regressed against the output which was the dependent variable and the five incentives were the independent variables.

Gross Margin Analysis: Budgeting techniques was used to estimate cost and returns of MFB farmers' beneficiaries. The specific type of budgeting technique used was the gross margin analysis. The model specification is stated thus:

$GM = TR - TVC$..... (1)

Where,

GM = Gross Margin

TR = Total Revenue

TVC = Total Variable Cost

TFC = Total Fixed Cost

Multiple Regression Model: This was used in this study to identify and explain the variable inputs used to explain the variation in output. Three functional forms were fitted for the data and these include linear function, semi log function and exponential function. Based on the work of Herbert (2003), the criteria for choosing lead equation were used. However, the best fitted equation was the linear function with highest R^2 and numbers of significant variables.

The implicit form regression model specification for the best fit model is thus;

$Y = F(X_1, X_2, X_3, X_4, X_5, X_6, U)$.....(2)

Where, Y = Farm output (Naira)

X_1 = MFB loan (Naira), X_2 = Cooperative loan (Naira), X_3 = Gift (Naira), X_4 = Subsidy (Naira)

X_5 = Mutual help (Naira), U = Error term

The model in its explicit form was as follow

$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + U$..... (3)

Where; β_0 = intercept and, $\beta_1 - \beta_5$ = slope coefficient of the independent variables

Result and discussion

Socio Economic Characterisation of Farmers: The characteristic of the sampled farmers that are MFB beneficiaries are presented in table 1. The average age of the farmers which are beneficiaries of the MFBs was 48 years in which about 68% of the respondents were between the ages of 41 to 55 while only about 10% of the respondents belong to the age group of above 55 years. Table 1 further showed that 77.14% of the respondents were male gender while 16 (22.86%) of the MFB beneficiaries were female gender. Majority of the farmers that are MFBs beneficiaries have tertiary school education while about 34% have secondary school

as their education status. Also, surprisingly about 61% of the farmers that are MFBs beneficiaries have household size between 1 and 5 and the average of household size of 4 which is not higher than the national average. More so, all of the farmers' enjoyed socio capital from family/relatives which was followed by cooperative society with 84% of the farmers benefited from socio capital through the association they belong to. However, the major forms of social capitals identified by the respondents were Cooperative loan, Mutual help and gift respectively in order of their magnitude.

Profitability of MFB Farmers' Beneficiaries: The average cost-benefit analysis of farm production of MFB beneficiaries is shown in Table 2. The result revealed that the total gross margin of the farm operation on the average of the 70 farmers sample selected was ₦232,887.87 (US $ 1168.82) per annum which is ₦19,407.32 (US $ 97.40) per month. This shows that agricultural production of the MFB farmer beneficiaries in the study area is very profitable since the return to capital was more than the 3% interest rate charge by the Micro finance banks and their respective cooperative society. The result also shows that the total variable cost which was ₦68,413.51 accounted for over 70% of the total cost of input used in production. However, this result supported the work of Daniel *et al;* (2010) that have found out that the variable cost accounting for the largest share of total cost in farm production.

Effect of MFB's Loan and Social Capital on Farmers Output: To assess the effect MFB loan and social capital on naira values of farmers' output, a regression analysis was carried out to model the farmers' output, as a function of five independent variables. The result of the regression estimate is presented in Table 3. The result shows that about 44% of the variation in Naira value of the farmers output was accounted for by the MFBs loan and their social capital benefits include in the model. The F-value of 16.031 indicated that the whole model is significant and is a good fit. Regression estimates showed that MFBs loan, cooperative loan, Gift, and mutual help had positive relationship with farmers' output. However, only MFBs loan, cooperative loan, gift and mutual help were found to be significantly related to the output of the farmers. When other factors are constant, a 1% increase in value of MFB loan, and cooperative loan resulted in an increase of 3.4%, and 5.3% of the farmers' output in Naira respectively other things remaining constant and this was found to support the findings of Arthur (2004), Fred *et al.,* (2011) and Obilor (2012), that there was a strong positive correlation between credit and net income.

Challenges Faced by the Farming Household in Accessing Loan From Microfinance Bank: The result in Table 4 showed that, inadequate loan was found to be the major constraints of MFBs beneficiaries in the study area which implies that there was high need to recapitalize the microfinance bank for greater challenges. This may probably be in consonance with Nigeria agricultural and rural development bank (NARDB), (1998) positing that the poor asset quality as well as high operating cost combined could erode the small capital base of the banks. The result also revealed that the challenge of inadequacy of fund was the most felt while the weather uncertainty was the least felt challenges by the farmer. This might be as a result that most of the farmer were not arable farmers but mostly poultry and fish farmers which may need adequate supply of credit for the day to day running of their farms and others which might be arable crop farmers might have been able to adapt or cope with the issue of climate change and they still believed that if they have more access to capital or credit their productivity might be increased.

Table 1: Socio economic characteristics of the respondents

	Frequency	Percentage
Age	15	21.4
Mean	48	68.6
26-40	7	10
41-55	(46)	
More than 55		
Mean Age		
Gender		
Female	16	22.86
Male	54	77.14
Education status		
Informal	6	8.57
Primary	6	8.57
Secondary	24	34.29
Tertiary	34	48.57
Household size		
1-5	43	61.43
6-10	27	38.57
Mean household size	(6)	
Source of social capital		
Cooperative society	59	84.29
Family/relative	70	100
Religion cycle	19	27.14
Friends/peer group	27	38.57
Commercial bank	5	7.14
Money lender	0	0.00
Social capital identified		
Cooperative loan	53	75.71
Gift	41	58.57
Subsidy	12	17.14
Mutual help	49	70.00
Grant and aid	8	11.43

Source: Computed from survey data, 2012

Table 2: Economics of MFB farmers' beneficiaries' production

Gross revenue/year (Naira)	324105.88
Total Fixed cost/year (Naira)	22804.50
Total variable cost/year (Naira)	68413.51
Gross cost/year (Naira)	91218.01
Gross margin/year (Naira)	232887.87
Gross margin/month (Naira)	19407.32

Source: Computed from survey data, 2012

Note: Official exchange rate: 1 US dollar = 199.25 Nigerian Naira.

(a) The figure shown are average for the 70 sample MFB beneficiaries farmers

Table 3: Regression Analysis showing the effect of MFB on the farmers output

Variable	linear coeffi.	t – value	Decision
X_1= MFBs loan	.508***	2.302	5%
X_2= Cooperative loan	.752***	3.510	1%
X_3= Gift	.372	.185	Not
X_4= Subsidy	-.153	.108	Significant
X_5= Mutual help	.296	1.448	Not
Constant	3.553		Significant
R^2	.469		
R^2 (adjusted)	.440		
F – value	16.031***		

Source: Computed from Field survey data, 2012
*** = significant at P < 0.01;** = significant at P < 0.05;* = Significant at P< 0.10
Dependent Variable: value of output in naira

Table 4: The challenges faced by beneficiaries of microfinance bank were ranked based on the degree of it felt need

Challenges	Highly Felt	Moderately	Slightly	Rarely	Not Felt	Mean	Rank
Inadequate of fund	23(32.9)	20(28.9)	17(24.3)	3(4.3)	7(10)	3.70	1st
Collateral Problem	2(2.9)	6(6.8)	25(35.7)	17(24.3)	20(28.6)	2.33	5th
Time of processing	16(22.9)	1217.1)	11(15.7)	16(22.9)	15(21.4)	2.97	3rd
Lateness of fund	12(17.1)	11(15.7)	20(28.6)	16(22.9)	11(15.7)	2.96	4th
Level awareness	7(10)	4(5.7)	12(17.1)	11(15.7)	36(51.4)	2.07	6th
Weather uncertainty	6(8.6)	2(2.9)	8(11.4)	20(28.6)	34(48.6)	1.94	8th
High interest	5(7.1)	9(12.9)	5(7.1)	10(14.3)	41(58.6)	1.96	7th
MFB/Group guidance	32(45.7)	6(8.6)	10(14.3)	17(24.3)	5(7.1)	3.61	2nd

Source: Computed from Field survey data, 2012.
NB: Figure in parentheses are percentages

Conclusion

The study examined the effect of micro finance bank loan on farmers' output in Kwara South Nigeria. Majority (77%) of the MFB beneficiaries were male and the mean (48 years) age of the respondents was still at the working class range. Majority of the farmers were literate and the mean household size of the farmer was six (6) which reflected from the level of the farmer education in the study area. Majority of farmers benefited from cooperative society loan and obtained social capital through their cooperative society, family and relatives network. The results obtained in this study also showed that the production of farmers that were beneficiaries of MFBs is a profitable venture in the study area. MFB loan and cooperative loan had a positive effect on farmers' outputs although; there are still rooms for improvement. More so, inadequacy of loan and lateness in time of delivery are the mostly felt constraints be the MFB farmers beneficiary.

Recommendations

The implication of this study for increased agricultural production in Nigeria is that MFB loan should be adequately given to farmers for effectiveness in their farm operations. The use of the loan should be monitored and supervised by the Banks through the farmers' cooperative society. Famers should also be trained with the help of extension agent on how to use their farm inputs optimally and to provide them information of the modern techniques or innovation in farming practices. Secondly, Microfinance bank should provide adequate and timely loan to

the farmers in order to avoid delay in their farm activities or operation. Finally, government should empower MFB farmer beneficiaries to remove the production constraints and inadequate fund, by putting in place good policy towards the empowerment of the MFBs in rural area and provision of a revolving loan to individual farmers.

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OPTIMIZATION OF THE PRODUCTION OF SODIUM SILICATE FROM RICE HUSK ASH

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Abstract

The conversion of rice husk which to sodium silicate was investigated. The rice husk was dried and ashed at various temperatures of 550°C, 600°C, 650°C, 700°C and 750°C. 25g of 0.15 mm size range of each sample was reacted with 0.5M sodium hydroxide solution at 80°C for 60 minutes. The average yields of sodium silicate obtained were: 2.20g, 3.25g, 5.45g, 5.15g and 5.02g respectively. Using the sample of ash produced at 650°C, the production process was optimized.The reaction temperature was varied using 80, 90, 100, 110, 120, 130 and 140 °C and optimum yield of 5.25 g sodium silicate was obtained at 120 ° C at a fixed concentration of sodium hydroxide solution and reaction time of 0.5 M and 30 minutes respectively. When the concentration of sodium hydroxide and reaction time were varied, the optimum yield of 19.80 g and 39.4 g sodium silicate were obtained at 2.5 M and 60 minutes respectively. From the results obtained, the optimum yield of 39.4 g sodium silicate was achieved at optimum operating conditions of temperature, time and concentration of 120 °C, 60 minutes and 2.5 M respectively. Some confirmatory tests were carried out to ascertain the presence and quality of the sodium silicate produced. The % Na_2O, %SiO_2, %H_2O and weight ratio of SiO_2/Na_2O were found to be 8.2%, 27.3%, 64.5% and 3.3 respectively while the specific gravity, viscosity and pH are 1.392, 198.52 and 12.2 respectively.These values are in close agreement with those obtained from a commercial grade sodium silicate. It can be inferred from the results of this study that production of sodium silicate from rice husk is possible.

Keywords: Optimization, Sodium, Silicate, Rice Husk, Ash

Introduction

Critical economic and environmental situations ofthe current days encouraged companies and researchers todevelop and improve technologies intended to reduce orminimize industrial wastes. As a consequence, much efforthas been expended in different areas, including the agricultural production (Ana Maria *et al*., 2009).

Rice is the second largest produced cereal in theworld. Its production is geographically concentrated in Asia withmore than 90 percent ofworld output (Real *et al*., 1996). The United States and Brazil are the most important non-Asianproducers and Italy ranks first in Europe. The rice worldproduction was approximately 400 million tons of milled rice in 2003 (Craig *et al*., 2010).

Rice husks makes up about 20% of the rice (paddy) weight. The rice millersworldwide thereforeshould generate more than 100 million tons of rice husks. Nowadaysalmost 70% of the rice husks are not commercially used (David, 2011).

All over the world the discharge of the husk accruing in the numerous ricemills causes a serious environmental problem. This agricultural waste howeverhas a significant calorific value and a high percentage of amorphoussilica. With an innovative technology these favorable characteristics of rice huskwill be used for solving the environmental problems and at the sametime producing electricity and high value industrial products (David, 2011).

Burning rice husk as fuel to generate energyresulted in a waste product, namely rice husk ash. Rice husk ash is rich in silica (92-97%) and can bean economically viable raw material for production of silica gel and silica compounds (Supitcha *et al.*, 2009).

Soluble sodium silicates (or water glass) are solutions of water and soluble glasses manufactured from varied proportions of $Na_2CO_3$and SiO_2 (Craig & Heather, 2010). Liquid Sodium Silicate is used to manufacture laundry soap, detergent cake, Sodium meta-silicate, fire resisting and acid proof cement, steel and alloy castings, electrodes, dyeing, printing, textile auxiliaries and ceramics. Because of its unique properties, sodium silicate is used in various applications to manufacture zeolite, construction chemicals, oil field chemicals, paints, pigments, paper making, paper cones, tubes, foundry, fluxes and fiber drum. Because of its binding properties Sodium Silicate is the best water proofing agent and it is also used in acid and alkali proof linings (Craig & Heather, 2010).

Optimization of the reaction variable allows obtaining the best conditions necessary to produce sodium silicate. The traditional way of achieving this task is the 'one variable at a time' approach. This traditional method involves keeping other variables constant and varying the one under test in other to find it's value at optimum yield (Yisa, 2011).

In order to utilize the potentials of rice husk ash produced from rice husk and to also solve environmental problems, this research is aimed at converting rice husk which is an agricultural waste to sodium silicate which is a raw material for many chemical processes.

Materials and Methods

Source of raw material and reagents: The raw material rice husk was obtained at a dumping site at Takowasa area in Bida, Niger state. The rice husk was washed to remove the dirt and sun dried to remove the moisture. The reagents used are NaOH pellets and Dilute Tetraoxosulphate (VI) acid.

Methodology

Ashing of rice husk: A known mass of 1000 g of dried rice husk was ashed in a muffle furnace in five batches of 200g per batch and the temperature set at 550°C for 24 hours for each batch. After each batch the content of the furnace was then discharged. The ashing process was repeated using different ashing temperature of 600°C, 650°C, 700°C and 750°C (Novotny*et al.*, 1991).

Preparation of standard solutions of NaOH: Electronic weighing balance (Adventure ARRW 60) was used to weigh 20g of NaOH pellets which was then placed in a 1500 ml beaker. Distilled water was added to it up to 1000 ml mark to give 0.5M. The resulting solution was properly stirred and stored in a plastic container. The procedure was repeated by dissolving 40g, 60g, 80g, 100g, 120g and 140g in the same quantity of distilled water to obtain 1.0M, 1.5M, 2.0M, 2.5M, 3.0M and 3.5M NaOH solutions respectively.

Effects of ashing temperature of rice husk on the yield of sodium silicate: A known mass of 25g of rice husk ashed at 550°C was placed in a stainless steel pot and 600 ml of 0.5M NaOH solution was added to it. The pot and its content were then transferred to a hot plate operating at 80°C. The mixture was continuously stirred for 60 minutes. The mixture was then allowed to cool after which it was filtered using filtration apparatus. The filtrate obtained was aviscous, transparent colourless, solution. The solution was then concentrated in an oven (GallikampSG 97-03-243) at 100°C for one hour. From the concentrated solution, the mass of sodium silicate produced was determined and recorded. The experiment was repeated with samples of rice husk ashed at 600°C, 650°C, 700°C and 750°C. Using the sample of rice husk ashed at 650°C, the above procedure was repeated in all the experiments carried outin optimization of the reaction variables for the production of sodium silicate from rice husk ash (Kalapathy*et al.*, 2000).

Optimization of the yield of sodium silicate from rice husk ash: The major reaction parameters that affect the yield of sodium silicate from rice husk ash are: concentration, temperature, and reaction time. It is therefore paramount to alter these process variables for the purpose of optimizing the yield.

Effect of reaction temperature on the yield of sodium silicate: The effect of reaction temperature on the yield of sodium silicate was investigated at ifferent temperature of 80, 90, 100, 110, 120, 130 and 140 °C, while the concentration of Sodium hydroxide and reaction time were fixed at 0.5M and 30 minutes respectively. At the end of eachexperiment, the yield of sodium silicate was measured and recorded (Akpan *et al.*, 2005).

Effect of concentration of sodium hydroxide on the yield of sodium silicate: The concentration of sodium hydroxide was varied using 0.5, 1.0, 1.5, 2.0, 2.5, 3.0 and 3.5 M, while the temperature of reaction and reaction time were fixed at 120 °C and 30 minutes respectively. At the end of each investigation, the yield of sodium silicate was determined and recorded (Akpan *et al.,* 2005).

Effect of reaction time on the yield of sodium silicate: The reaction time of 30, 45, 60, 75, 90 and 105 minutes were used for the investigation, while the temperature of reaction and concentration of sodium hydroxide were fixed at 120 °C and 2.5 M respectively. At the end of each investigation, the yield of sodium silicate was determined and recorded (Akpan *et al.* 2005).

Confirmatory test for sodium silicate solution: Some standard tests were carried out on the final product produced to confirm the presence and the quality of sodium silicate after which the results were compared with those of a commercial grade sodium silicate.

Determination of percentage sodium oxide (%Na_2O): A known mass of 25 g of Commercial grade sodium silicate solution was diluted to 500 ml with de-ionized water. A 50 ml Aliquot was then titrated with 0.2 M Hcl until the pH of the mixture Become 4.3. The average titre value was calculated and recorded. This procedure was repeated using the sample of sodium silicate produced. In each case, the % Na_2O was determined using equation 1(Oxychem, 2002).

$$\% N_2O = \frac{\text{Titre value of Hcl} \times \text{Normality of Hcl} \times 3.1}{\text{Weight of silicate sample}} \quad (1)$$

Determination of percentage silica (% SiO_2): About 10 g of the commercial grade sodium silicate sample was diluted to 50 ml with distilled water. The resulting solution was then acidified with 200 ml of 0.2 M Hcl acid. The mixture was then evaporated todryness on a hot plate. The solid obtained was rinsed with distilled water to remove possible chlorides after which it was then ignited in a muffle furnace for 15 minutes. The final residue was then weighed and the % SiO_2 was calculated using equation 2 (Oxychem, 2002).

$$\% SiO_2 = \frac{\text{Mass of final Residue}}{\text{Weight of initial silicate sample}} \times 100 \quad (2)$$

Determination of percentage water (% H_2O): The percentage water content was calculated by the difference method using equation 3 (Gregory, 2005).

$$\% H_2O = 100 - (\% Na_2 + \% SiO_2) \quad (3)$$

Determination of pH, Viscosity and Specific gravity: The pH, Viscosity and Specific gravity of both the commercial grade and the sodium silicate produced were measured using pH mater, Viscometer and Hydrometer respectively (Oxychem, 2002).

Results and Discussion

The effect of ashing temperature on the yield of sodium silicate from rice husk was carried out due to the fact that the presence of crystalline or amorphous silica or both in rice husk ash depends on the burning temperature at which the ash is produced as reported by Yalcin and sevinc (2001). Considering the result obtained in Figure 1.0, the average mass of silicate obtained from rice husk ash produced at 550 ^oC was 2.2 g. As the temperature increases by 50 ^oC, the mass of silicate obtained was 3.25 g. The ashes produced at temperatures of 650 ^oC, 700 ^oC and 750 ^oC yielded 5.45, 5.15 and 5.02 g of sodium silicate respectively. As can be seen, the yield of Na_2SiO_3 increases sharply from ashes produced at temperature range of 550 to 650 ^oC after which the rate of increase in yield declined from the ashes produced at temperatures of 700 ^oC and 750 ^oC.

Since amorphous silica is more soluble than crystalline silica it can be deduced from this result that ashing temperature of 650 ^oC produced more amorphous silica which favour the yield of Na_2SiO_3. Ashing temperatures above 650 ^oC favour the production of crystalline silica which hinders the yield of Na_2SiO_3.

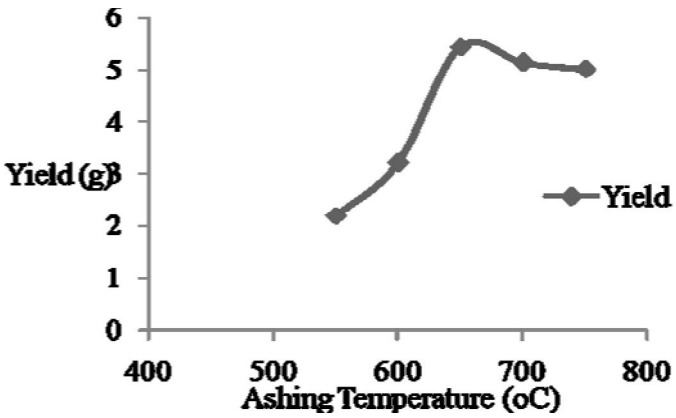

Figure 1: Effects of ashing temperature on the yield of sodium

The optimization of the yield of sodium silicate from rice husk ash was conducted using the rice husk ashed at 650°C during which the three major reaction parameters which are temperature, concentration and reaction time were varied for the purpose of obtaining optimum conditions.The effect of reaction temperature was put into test by fixing the reaction time and the concentration of sodium hydroxide at 30 minutes and 0.5 M respectively while the reaction temperature was varied between 80 to 140 ^{o}C using a step change of 10 ^{o}C. The result obtained presented as shown in Figure 2. As can be deduced from the curve, the yields of sodium silicate increase significantly with the increase in reaction temperature range of 80 to 120 ^{o}C. At the reaction temperature of 80 ^{o}C the yield was 1.4 g, while the yields at 90, 100, 110 and 120 ^{o}C are 2.25, 3.35, 4.25, and 5.25 g respectively. The effect of temperature on the yield diminishes in vigor at temperatures of 130 and 140 ^{o}C with numerical values of 5.45 and 5.65 g respectively. From this result, the temperature of 120 ^{o}C can be selected as the optimum for the optimal yield of sodium silicate.

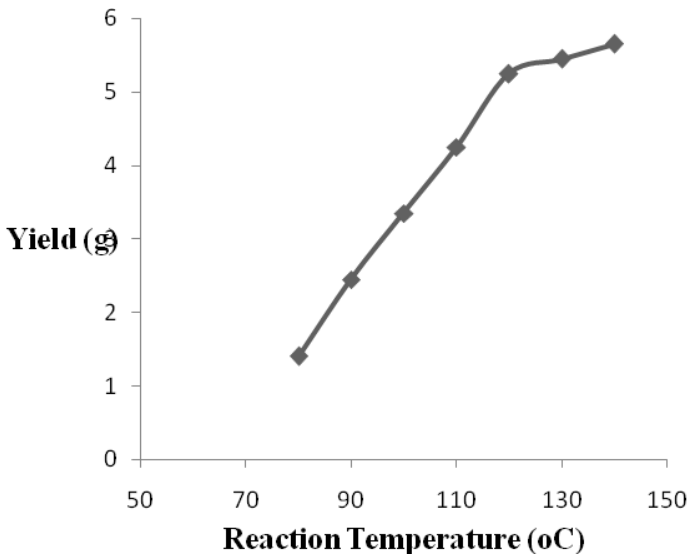

Figure 2: Effects of reaction temperature on the yield of sodium silicate

The effect of concentration of sodium hydroxide on the yield of sodium silicate from rice husk ash was investigated keeping the reaction temperature and time constant at 120 ^{o}C and 30 minutes respectively. As expected, the yield of sodium silicate increases with increase in concentration of sodium hydroxide. Referring to Figure 3, significant increase in yield was observed between the sodium hydroxide concentrations ranges of 0.5 to 2.5 M with values of the yields being 5.25, 8.80, 11.65, 16.15 and 19.80g at sodium hydroxide concentrations of 0.5, 1.0, 1.5, 2.0 and 2.5 M respectively. At sodium hydroxide concentrations above 2.5 M, the increase in yield was not significant. At NaOH concentrations of 3.0 and 3.5 M, the yields of silicate were 20.0 and 20.3 g respectively. At these concentrations, the amount of NaOH is in excess of what is required for the production of silicate from the limiting reactant which is the rice husk ash (RHA). By this result NaOH concentration of 2.5M is considered more favorable for the production process.

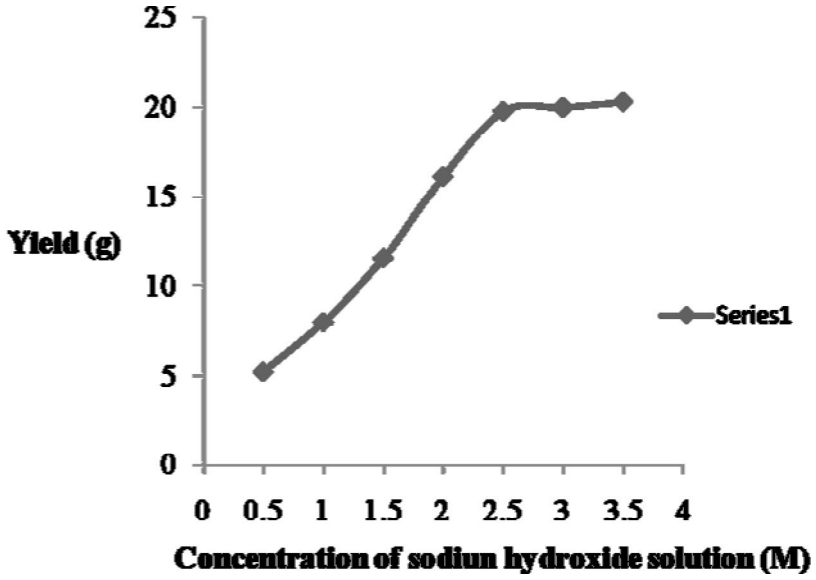

Figure 3: Effects of concentrationof sodium hydroxide on the yield of sodium silicate

The reaction time was varied with the aim of determining the suitable time that will give the optimal yield at the optimum conditions of temperature and concentration earlier investigated which are 120 ^{o}C and 2.5 M respectively. From Figure 4 it was observed from the curve that the yields increased vigorously between 30 to 60 minutes of reaction after which the rate of increase in yield declined between 75 to 105 minutes. This decline in the rate of increase in yield between 75 to 105 minutes may be attributed to the fact that the concentration of silica in the ash (The limiting reactant) could have drastically reduced due it being converted to sodium silicate before these reaction times. So therefore, the reaction time of 60 minutes can be considered more appropriate for the optimum yield at the optimum conditions of temperature and concentration.

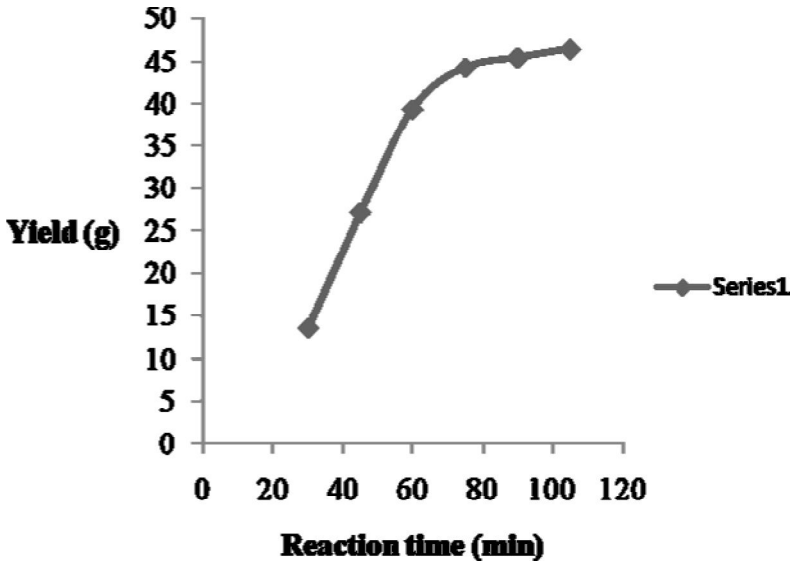

Figure 4: Effects of reaction time on the yield of sodium silicate

Some standard tests were carried out on the sodium silicate produced to confirm it presence and quality by comparing the results with that obtained from a commercial grade sodium silicate. The results of these tests are showed on Table 1. As can be seen from the results, the percentage Na_2O, SiO_2 and H_2O for the sodium silicate produced are: 8.2, 27.3 and 64.5 % respectively while that f the commercial grade was 9.1, 29.2 and 61.7 % respectively. When these results are compared it can be deducted that the sodium silicate produced is more diluted than the commercial grade due to higher percentage of water content. On the other hand, when the SiO_2/Na_2O ratio were compared, both samples falls within the standard range of 1.6-3.3 with the commercial grade having SiO_2/Na_2O ratio of 3 .22 and the sample produced from rice husk ash with a ratio of 3.3. When the specific gravities were compared, both have a value of approximately 1.4. The viscosity of 198.52 centipoises for the silicate produced is lower than the 206.25 recorded for the commercial grade. This may be attributed to the higer percentage of water in the sample produced. The pH recorded for the commercial grade was 11.3 while that of the sample produced was 12.2.

Conclusion

The effect of ashing temperature on the yield of Na_2SiO_3 shows that more amorphous silica which is more soluble than crystalline silica was produced at temperature of 650^oC thus giving the highest yield of sodium silicate. The production process was successfully optimized and the reaction variables optimized includes: reaction temperature, sodium hydroxide concentration and reaction time with optimum values of 120 ^oC, 2.5 M and 60 minutes respectively.

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COMPARATIVE ASSESSMENT OF POVERTY STATUS OF USERS AND NON-USERS OF MICRO CREDIT BY FARMERS IN KWARA STATE, NIGERIA

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Abstract

Poverty is one of the most retarding and devastating factors in human life.Micro credit could be a viable ingredient in the alleviation of poverty. However, studies that comparatively assess the poverty status of users and non-users of micro credit are scanty. The essence of this study is therefore to assess the impact of Micro credit on farmers' poverty status in Kwara state, Nigeria. The study describe the socioeconomic characteristics of the respondents, analyzed the determinants of the poverty status as well as extent of poverty among the users and non-user of microcredit. Cross sectional data was obtained through well-structured questionnaires administered randomly to both users and non-users of Micro credit facilities in Kwara state. For the purpose of this study, 50 users and 100 non-users of Micro credit facilities were selected. Descriptive statistics, logistic regression model and Foster-Greer-Thorbecke (FGT) model were used to analyze the data collected. The result revealed that majority (96%) of the users of microcredit had some level of formal education while, majority (88%) of the non-users had no formal education. The poverty incidence of non-users is 63% while, that of users is 52%. Among the determinants of the households' poverty status, age of the household head and the household size had positive relationship with the household's poverty status. While, farm income, assess to credit as well as belonging to a poverty alleviation group had a negative relationship with the household poverty status.The study therefore recommends that policies that would encourage the use of microcredit by farmers should be put in place. Family planning campaign programmes should also be put in place since the result shows that households with larger family size has a higher tendency of been poor.

Keywords: Micro credit, poverty, income inequality, household income

Introduction

Poverty is a universal phenomenon that affects socio-economic and political well-being of its victims whether in a developed or underdeveloped country, however, available statistics shows that poverty in poor country is absolute and more pronounced in the rural areas (Owuor et al., 2007).

The ultimate goal of agricultural production plans in national development is to raise the standard of living and one of the important yardsticks for measuring standard of living is the average distribution income. According to World Bank (2005) report, there is an existence of high level of income inequality in many low income countries of Sub-Saharan Africa in which Nigeria is inclusive. This high income inequality has been also reported to produce an unfavourable environment for economic growth and development. National Bureau of Statistics(2010) reported that income inequality among households in Nigeria rose from 0.429 in 2004 to 0.447 in 2010, indicating greater income inequality during the period.

The proportion of Nigerians living below the poverty line of one dollar per day has increased dramatically during the last decades (Landes, 2010). Poverty in Nigeria is on the increase and its incidence and severity are more in the agricultural sector. It is a major problem which is more prevalent in the rural areas as 75% of the poor people in the developing countries are in the rural areas characterized by low productivity, small scale enterprise and crude system of farming (Owuor et al., 2007).

Micro credit has evolved as an economic development approach intended to benefit low income men and women, thus regarded as an effective tool for economic development (Zahra, 2008; Ojo, 2009). An effective economic development programme is one in which the poor are the agents of change. The poor do not need aid, they need opportunity (Tessi, 2005) thus promoting economic growth, reduce poverty, support human development and improve the status of urban-rural communities. For the past 20 years, the government, international agencies and social organizations have been focusing on rural and women's development Programmes (Rieneke, 2010; Shanti, 2008) one of the priorities of the Millennium Development Goal is poverty alleviation and economic development, women's empowerment and gender mainstreaming.

According to Kevin (2009) most of the poor farmers have little financial opportunity thus micro-credit could help poor people who have no collateral. Most Nigerian micro entrepreneurs are economically isolated, which means that their market is often local, small and does not offer any demand growth prospects. Commercial banks and other financial institutions normally do not like to go in that area because of the geographical constraints, underdeveloped infrastructure and other physical constraints. On the other hand, there is a substantial demand for micro credit.

However, despite the benefits of micro-credit, its users are being faced with a lot of difficulties ranging from inadequate access to loan, high interest rates on loans as well as low micro credit range. Some of the difficulties arising as a result of inadequate access to credit include insufficient fund to establish storage facilities, inadequate processing facilities, poor linkage with the market and bad roads (PCU-NFDO, 2005). These problems affect the level of productivity and inhibit full utilization of potentials of Micro credit thereby leading to low profitability, low level of income and poor standard of living.

Literature Review

According to Central Bank of Nigeria (2006) "microfinance is the provision of a broad range of financial services such as deposits, loans, payment services, money transfers, and insurance to poor and low income household and their micro-enterprises. Thus, microcredit is a subset of microfinance.

Concept of Microcredit: Microcredit can be defined as provision of thrift, credit and other financial services/ products of very small amount to the poor in rural, semi-urban and urban areas for enabling them to raise their income levels and improve living standards. Microcredit entails the provision of credit facilities to the poor who are not well served by the conventional financial institutions. It has 3 features that distinguish it from other formal financial products (Nwobi, 2010). These are:

(a) Simplicity of operation;
(b) Smallness of loan;

(c) Absence of asset based collateral

This situation has attracted the attention of the Nigerian government and led the Federal government into creating specialized institutions such as the Nigeria Agricultural cooperative and Rural Development Bank (NACRDB) to cater for Credit needs in the Agricultural sector (Oladebe, 2005). NACRDB was renamed Bank of Agriculture in 2010. The specific objective is to act as a development finance institution for delivering credit to the Agricultural sector of the economy. The provide loans to individual farmers, cooperatives, state and federal government agencies. This enables the small-scale farmers to establish and expand their production, enhance food sufficiency, promote household income etc., so as to eradicate poverty.

Impact of Credit on Farmers Poverty Status: Obisesan (2013) analyzed credit accessibility and poverty among small holder cassava farmers in south western Nigeria. Descriptive analysis, Logit regression model and the Foster- Greer Thorbecke class of poverty measures (FGT) were used in this study. The result shows that households with no access to credit had highest poverty incidence with 74.5% described poor.Adewusi (2007) conducted a study on rural livelihood and poverty in Oyo State, Nigeria. The author employed logit model for the data analysis. The results of the logit model revealed gender, years of formal education, access to electricity, access to improved seed, access to veterinary services, distance to the nearest tarred road and access to formal credit facilities were the significant variables.

Babatunde *et al.,* (2008) on the other hand, conducted a study on rural households' poverty in South Western Nigeria. They used exponential model and log of per capita expenditure as the dependent variable. They found that the male gender (dummy), level of education of head of household, farm size, land ownership and membership of farmers' group were positive and significantly related to household's per capita expenditure.

There are some available studies such as: Adams (2007), Olorunsanya et al., (2009), Babatunde et al. (2008), Landes (2010), Olawuyi et al. (2013) that have analyzed poverty status of rural dwellers as well as impact of Micro-credit on poverty. Nevertheless, there appear to be little or no study that had made comparism between the poverty status of users and non-users of Micro-credit facilities, particularly in Kwara state, Nigeria. This gap in knowledge is what this research hopes to fill.The study seeks to answer the following questions: what are the socioeconomic characteristics of the respondent? What are the determinants of the poverty status of the respondents? As well as what is the poverty status of both users and non-users of micro credit? This research has two main objectives. First, it assessed the poverty status of the users and non-users of Micro credit in Kwara state. Second, it analyzed the factors influencing the poverty status of the sampled respondents.

Methodology

The Study Area: This study was conducted in Kwara State, north central Nigeria. Kwara State was chosen for this study because it is among the six poorest in Nigeria in terms of undernourishment and income poverty. About 83% of the population of the State classified themselves as being poor (NBS, 2006). It shares boundaries with Osun, Oyo, Ondo, Kogi, Niger and Ekiti states. Kwara State shares an international boundary with the Republic of Benin in the west. The State has a population of about 2.37million people (NPC, 2006) out of which farmers account for about 70%. The average population density of the state as at 2006 was about 73

people per square kilometer. There are a total of 1,258 rural communities in Kwara State (NPC, 2006). Based on agro-ecological and cultural characteristics, the state is divided into four agricultural zones –zones A, B, C and D, by the Kwara State AgriculturalDevelopment Project (KWADP).

Sampling Techniques: Data used for this study were collected in the year 2014. A three-staged sampling technique was adopted for the study. First, three LGAs were randomly selected from the 16 LGAs in the state. This was followed by purposive selection of five farming communities in each of the selected LGAs. Then, structured questionnaires were administered to ten (10) farming households, giving a total of 150 respondents. The 150 respondents comprises of 50 users and 100 non-users.

Analytical Techniques: Descriptive statistics was used to describe the socio economic characteristics of the farmers.*Logistic model* was used to analyze the determinants of poverty status of the farmers.As such, logistic regression was most appropriate for this study due to its unique ability to account for both categorical and dichotomous dependent variables. The model was specified in the implicit form as follows:

Logit $(E[Y]) = Logit(P) = XT\beta$

Where:

Logit $(E[Y])$ = is the binary response/dependent variable

Logit (P) = the natural log of the odds of success

XT = the explanatory/independent variables

β = is the regression co-efficient

The dependent variable was a dichotomous variable depicting the respondent' poverty status and took the value of 1 if the respondent was poor and 0 if not. The independent variables were the socio-economic factors.

Foster-Greer-Thorbecke (FGT) poverty index was used to depict the extent of poverty among the users and non-users of Micro credit in the study area. The poverty aversion parameters employed were P_0, P_1, and P_2 which means poverty incidence (headcount), gap (depth) and severity respectively.

Results and Discussion

Data and Sample characteristics

Table 1: Socio-economic Profile of the Respondens

Variable	Category	Users (50)		Non-users (100)	
		Frequency	Percentage	Frequency	Percentage
Age	≤ 22	1	2.0	0	0.0
	23-32	4	8.0	6	6.0
	33-42	17	34.0	20	20.0
	43-52	22	44.0	25	25.0
	53-62	4	8.0	12	12.0
	63-72	2	4.0	17	17.0
	73 and above	0	0.00	20	20.0
Marital status	Single	3	6.0	8	8.0

	Married	46	92.0	82	82.0
	Divorced	1	2.0	6	6.0
	Widowed	0	0.0	4	4.0
Sex	Female	4	8.0	0	0.0
	Male	46	92.0	100	100.0
Educational level	No Formal	2	4.0	88	88.0
	Primary	12	24.0	11	11.0
	Secondary	7	14.0	1	1.0
	NCE	5	10.0	0	0.0
	OND	9	18.0	0	0.0
	HND	9	18.0	0	0.0
	University	6	12.0	0	0.0
Annual household income	<= 11000.	0	0.0	35	35.0
	11001-31000	0	0.0	63	63.0
	31001-51000	12	24.0	2	2.0
	51001-71000	11	22.0	0	0.0
	71001-91000	4	8.0	0	0.0
	91001-111000	5	10.0	0	0.0
	111001-131000	3	6.0	0	0.0
	131000 and above	2	4,0	0	0.0
Access to credit	Yes	48	96.0	0	0.0
	No	2	4.0	100	100.0
Household size	1-6	49	98.0	8	8.0
	7-12	1	2.0	32	32.0
	13-18	0	0.0	55	55.0
	19 and above	0	0.0	5	5.0
Membership of cooperative	Yes	48	96.0	43	43.0
	No	2	4.0	57	57.0
Farm Enterprise	Arable farming	35	70.0	100	100.0
	Processing	12	24.0	45	45.0
	Livestock farming	32	64.0	10	10.

Source: Field survey, 2014

The result in table 1 revealed that the average age of household head in the study area was about 53 years old while, the majority of the respondents (47%) were found in the age bracket 43 – 52 years. This indicates that majority of the respondents were getting old and this might decline productivity as well as a threat to food production vis-a-vis impoverish the farming households. It was also shown that over 87% of the sampled respondents have married which implies that most of the respondents were mature and responsible to cater for their households as well as have clear knowledge of their wellbeing. About 60% of the respondents had no formal education, while the remaining ones were educated either by primary (17.5%), secondary (7.5%) and tertiary (14.5%) schools communicates that majority of the farming households were literate and one would deduce that this would alleviate poverty in the study area.

Household size has been seen as one of the major determinants of poverty that is positive to being poor in this part of the world. The mean household size was 8 persons per house and the majority of the respondents (43.3%) fall between 7 and 12 persons per house. Income has

been a vital tool in accessing human wellbeing. About 62.0% of the sampled households earn less than ₦ 31, 001 per month. While, just only one farming households earn over N131, 001 per month. The average household income was ₦ 37068.6 which means that looking at the responsibilities of these people couple with their household size, there is need to improve on household income in order to alleviate poverty in the study areas.

The study further gave insight to the type of farm enterprise ventured into in the study area using multiple responses. It was revealed that 85% of the respondents were into arable crop farming, while 34.5% of the households were into processing and just 37% of them were into livestock or animal husbandry.

Table 2: Frequency Table of monthly Income of micro credit users before and after accessing microcredit

Income range (N)	Frequency before		Frequency after	
<= 10000	1	2%	0	0%
10001-20000	8	16%	0	0%
20001-30000	17	34%	0	0%
30001-40000	12	24%	6	12%
40001-50000	6	12%	13	26%
50001-60000	1	2%	6	12%
60001-70000	4	8%	8	16%
70001-80000	1	2%	3	6%
80001+	0	0%	14	28%
Total	50	100%	50	100%
Mean	35680		67,600	
Minimum income	10,000		32,000	
Maximum income	80,000		145,000	

Source: Field survey, 2014

The result in table two shows that the users of micro-credit were better off after the usage than before micro-credit usage. About 52% of the farmer are earning income between >₦10, 000 and ₦30,000 but, after they became users of micro-credit all of them had move above this level. The minimum income of the users before was ₦ 10,000. It had now become ₦ 32,000. The maximum income of the users before accessing micro-credit was ₦ 80,000 but this has increased to ₦ 145,000 after the usage of micro-finance.

Econometric Analysis and Results

FGT poverty index was used to depict the extent of poverty among the farming households in the study area. The poverty aversion parameters employed were P_0, P_1, and P_2 which means poverty incidence (headcount), gap (depth) and severity respectively.

Table 3: Poverty Incidence, Depth and Severity of Respondents

	Incidence(P_0)	Depth(P_1)	Severity(P_2)
users of microcredit	0.52	0.058846	0.043279
Non-users of microcredit	0.63	0.1202	0.008392

Source: Field survey, 2014

The poverty status of the respondents were shown in table 3.The poverty incidence shows that among the micro credit users, 52% of the population were poor while among the non-users of micro credit 63% of the population were poor. The poverty depth of the users and non-users are 0.0588 and 0.1202 respectively .This implies that their per capita household income would need to be increased by 5.88% and 12.0% respectively for them to come out of poverty and become non-poor .The poverty severity measures the distance of each poor person to another. Among the users the distance is 0.04327 while in the non-users the distance is 0.0083. A comparison of the poverty status of the users and non-users shows that the poverty status of non-users is higher than that of the users.

Table 4: Logistic Regression Result on the Determinant of Poverty Status

Variable	Coefficient	Standard error	z-value	p>|z|
Education	1.887416	1.49718	1.26	0.207
Farm size	.0998424	.0996288	1.00	0.316
Total household asset	-.0000808**	.0000313	-2.58	0.010
Age	.8195713 *	.4315403	1.90	0.058
Household size	2.579717 ***	.7857872	3.28	0.001
Access to credit	-2.384505***	.832154	-2.87	0.001
Belonging to a poverty alleviation group	-3.977612**	1.547435	-2.57	0.010
Constant	-8.528851**	4.142843	-2.06	0.040
Chi^2 = 169.54				
Pseudo R^2 = 0.8365				
Log likelihood = 16.572317				

Note: ***, ** and * = Figures significant at 1%, 5% and 10% significant levels respectively
Source: Computation from Field Survey Data, 2014

Moreover, the likelihood function of the model was significant (Wald = 16.572317, with p < 0.0000) showing strong explanatory power of the model.

Table 4 shows factors influencing poverty status of the respondents. The chi-square of 169.54 obtained in the study implies that the parameters included in the logistic model are significantly different from zero at the 1 per cent significant level.

The results of the regression model indicated that five of the explanatory variables influenced the poverty status of the respondents. Variables that positively affected poverty status include age and household size that is, the higher their age and household size, the poorer they become. This can be justified based on the fact that an increase in age could result in decline in strength,vigor and productivity. Household size also increases the likelihood of being poor and this could be because of increase in household size directly reduces income per-head (per-capita income) as well as impair standard of living of the households (Asad, 2007).

On the other hand, farm income, access to credit, belonging to a poverty alleviation group had negative coefficients and significantly affects the level of poverty in the study area. An increase in the value of any of these variables increases the likelihood of not being poor. This implies that farming household that belongs to any poverty alleviation group, access to agricultural credit vis-à-vis increase in farm income may likely be non-poor in the study area.

Conclusion and Recommendations

Going by the empirical evidence emanating from this study, the majority of the rural farming households in the study area were poor. The level of income disparity was high and they struggled to find a means of coping with the syndrome of poverty. It therefore suggests a number of policy options that can assist in alleviating poverty. These options are: Policies that will encourage farmers to go into massive production should be put in place. Increased productivity would lead to greater farm income for the farmers. Stakeholders should encourage youths to go into farming so as to reduce pressure that is on white collar jobs. Awareness creation on family planning will go a long way in reducing the household size of the rural farming households since there is tendency of being poor with large household size. Credit facilities should be made available and accessible to the farming households. The poor should be encouraged to save. Borrowers should be encouraged to invest in low risk income generating Agricultural activities.

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EVALUATION OF REFRACTORY PROPERTIES OF SELECTED CLAY SAMPLES FROM SOKOTO STATE, NORTH WEST NIGERIA

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Abstract
This study presents the results of characterization of the refractory properties of some selected clay deposits from Sokoto State in Nigeria. Characterization of the clays was carried out to determine its physical properties and chemical composition. The result of analysis shows that the clay samples were of high silicate content with Wamakko and Illela having a composition of 54.27 and 58.31 %. The clays were also found to have moderate alumina content of 23.57 and 27.56 % respectively and low ferrous oxide content (< 3 %). It also possesses very low contents of other metal oxides. The low iron content gives the clay rather whitish appearances suggesting its suitability for paint, chalk, and earthenware manufacturing. All the clay samples had refractoriness above 1500 ^{o}C establishing the potential for handling of ferrous metal and lining of furnace wall. The thermal shock resistances within the range of 23 and 26 cycle Wamakko and Illela clay sample further establish their suitability for use as fire clay refractory's. The clays samples investigated have quality characteristics for their potential application in the production of floor tiles, fire refractory brick, paint, chalk, and earthenware manufacturing.

Keywords: Refractories, Clay, Northwest, Fireclay, Characterization, Wamakko, Illela

Introduction
Refractories are mostly made up of inorganic compounds which are usually derived from clay. It is characterized by the ability to withstand physical, chemical and corrosive attack without deterioration at elevated temperatures (Musa *et al.,* 2012). These materials are mostly used in metallurgical industries for the linings of internal furnaces wall, melting, holding and transportation of metal and slag. It is also widely used in varieties of industries such as glass manufacturing, cement, petroleum and ceramics industries (Waing *et al.,* 2008).

In the last few years, the possibility and significant application of refractory materials in the industrial growth of Nigeria have been receiving serious attention (Abolarin *et al.,* 2004). According to Amuda *et al.* (2005), there will be a high demand for refractory materials with the anticipated completion and subsequent commissioning of Ajaokuta Steel industry which have a production capacity of 1.3 million tonnes of liquid steel. Ndanusa *et al.* (2005) added that the industry will require approximately over sixty million naira for about 36,000 tonnes of refractory bricks for lining furnace wall only. The authors further stated that fired clay constitute over 80 % of the bricks that will be required for this purpose. It was also reported that between 1997 and 2002 about $850 million dollar was expended on the four Nigeria indigenous refineries during its turn around maintenance (TAM). Fluid Catalytic Cracking (FCC) is the most vital unit in the TAM process. This unit is lined with large number of different grades of refractory bricks (Borode *et al.,* 2002). The Chemical, hardware, cement and glass industries are also in serious need of these refractory materials. The demand of these industries is far greater than 300,000

tonnes as at the year 2000 (Ndaliman, 2007). These refractory materials are sourced by importation (Borode *et al.,* 2002). Meanwhile the primary raw materials for the production of refractory are magnesites, dolomites-chrome ores, spinel and clay (Waing *et al.,*2008).

In Nigeria abundant deposits of clay have been reported across major geological belt (Musa & Aliyu, 2011). But it is surprising that the growth of refractory industries in the country is still at its infancy stage. The present economic meltdown in the nation and uncertainty facing the petrochemical, metallurgical and other allied industries has necessitated the need to source for local raw materials to nurture the growth of these industries. This will lead to the production of high quality commercial refractory which will eventually substitute for importation and help to save the much needed foreign exchange (Musa *et al.,* 2012).

This has stimulated the recent efforts to explore and improve the properties of Nigeria clay for relevant industrial application (Musa & Aliyu, 2011). Several researches have been documented on the properties and application of Nigeria clay for relevant industrial application. However most of the clay studied reported are limited to clays deposit from the following geological belt; East (Nnuka & Agbo,2000; Chukwudi, 2008; Ameh & Obasi,2009; Osaremwinda & Abel ,2014; Odewale *et al.,* 2015), southwest (Amuda *et al.,*2005; Omotoyinbo & Oluwole., 2008; Oloruntola *et al.,* 2010), North central (Isah, 2010; Musa *et al.,* 2012, Manukaji, 2013), North East (Abolarin *et al.,* 2004; Abdullahi & Samaila, 2007; Aremu *et al.,* 201), South South (Osaremwinda & Abel, 2014).

It is evident from literature that no attempt has been made to characterize Clay Deposits in the North Western Nigeria specifically Sokoto state to the best of the authors knowledge. This work is aimed at characterizing some selected clay samples in North West Nigeria clay deposits with a view of ascertaining its suitability as a refractory material for relevant application in Nigerian manufacturing industries.

Materials and Methods

The basic raw materials used in this work are clay obtained from two different (Wamakko and Illela) locations within Sokoto states in the northwest Nigeria: Sokoto state.

Sample Preparation

The clays from the various deposits were crushed and grounded to fine grains. The samples were moulded with adequate amount of water and then moulded into test laboratory sizes of rods of length 85 mm by 45 mm diameter after which they were air dried for 24 hours and oven dried at a temperature of 110 ^{0}C for 12 hours. The rods made from this samples were then fired in an electric muffle furnace at 1000 ^{0}C for 8 hours. The firing was done at a slow rate to avoid the cracking of the rods. The rods were then cooled at the rate of 15 ^{0}C per minute to room temperature making the rods ready for testing (Plate II).

Plate II: Moulded Cylindrical Rods Ready for Analysis

Characterization

Atomic Absorption Spectrophotometer (AAS)

The chemical composition of the raw clay samples in weight % of (SiO_2, Al_2O_3, CaO, MgO, Na_2O and Fe_2O_3) was determined using AAS (model 210 VGP) at the Chemical Engineering Laboratory of Federal Polytechnic, Bida, Niger state.,

Determination of Loss on Ignition (LOI)

The water content of the clay was determined by measuring the weight loss of mass of a sample after firing in the furnace at 1000 ^{0}C for 1 hour thirty minutes. Loss on ignition was calculated using this relation:

$$LOI = \frac{W_i - W_F}{W_i} \times 100\ \% \qquad (3.1)$$

Where W_i and W_f are initial and final weight of the clay respectively.

Determination of Bulk Density

Test sample of 85 mm x 45 mm were prepared for all the clay under investigation. Each of the samples was air dried at a temperature of 110 ^{0}C in oven for 24 hours. The samples were cooled after drying and weighed accurately. The samples were then heated for another 30 minutes to ensure that all trapped air were appreciably evacuated and the second weight reading of sample (w) are taken after cooling and soaking the samples in water. The samples were then suspended in water and the suspended weight (S_S) taken. The bulk density was calculated

$$B_D = \frac{D_\rho}{W_S - S_S} \qquad (3.2)$$

Where D- dried weight, W_S soaked weight and S_S suspended weight all in gram (g)

Determination of Thermal Shock Resistance

The test samples were inserted into a furnace that was kept at 1100 ^{0}C. This temperature was maintained for about 10 minutes. The samples were removed one after the other with tongs and then cooled for ten minutes. The samples were returned to the furnace again for a further 10 minutes. The process was continued until there is conspicuous crack on the clay rods as shown in plate III. The number of cycles withstand before fracture were recorded for each sample.

Plate III: Cracked Clay Rods

Determination of Cold Crushing Strength

The samples were placed on a compressive testing machine. Load was then applied axially by turning the hand wheel at a uniform rate until failure occurs. Using a well calibrated scale, the maximum load was taken as the crushing load. The cold crushing strength was then determined using the formula;

Cold Crushing Strength (CCS) = $\frac{Maximum}{Cross\ sectional\ area}$ (3.3)

Determination of Refractoriness

The refractoriness of the rods could not be determined experimentally because the rods were fired to limited temperatures between 900 – 1100 ^{o}C but was estimated using Shuen's formula (Odo *et al.,* 2009).

$$K = \frac{360 + AL_2\ O_3\ - Ro}{0.228} \quad (3.4)$$

Determination of Linear Shrinkage

Linear shrinkage was determined by measuring the dimensional changes on both the wet and fired rods using a Vernier calliper. The linear dried dimensions were measured after air drying overnight. The linear shrinkage was determined using the relationship shown in equation

$$LS = \frac{\Delta L}{L} \times 100\ \% \quad (3.5)$$

Where **Δ**L is change in length of the rod and L is the original length of the rod.

Determination of Apparent Porosity

The 85 mm rod was dried in an oven at 105 °C for 1 hour to dry the samples. The weight of the dried weight in air (Wa) was taken, before sample was put into boiling water for 15 minutes to remove trapped air bubbles. It was then allowed to cool after which the weight of the soaked sample (Ws) was taken. The sample was removed from water and cleaned up and weighed again in air and the saturated weight (Wss) determined. Apparent porosity was evaluated using the formula:

$$AP\ (\%) = \frac{volume\ of\ water\ absorbed\ after\ boiling}{bulk\ vuolume}$$

$$= \frac{Wss - Wa}{Wss - Ws} \times 100\ \% \quad (3.6)$$

Results and Discussions

Table 1 shows the results of chemical composition respectively for the clay samples:

Table 1.0: Chemical Composition of Clay Samples

Clay	Al_2O_3	MgO	SiO_2	CaO	Fe_2O_3	Na_2O
Wamakko	23.57	0.006	54.27	0.010	0.015	0.168
Illela	27.26	0.059	58.31	0.013	2.730	0.720
[1]Onibode, Ogun State	37.40	-	50.80	-	5.80	-
[2]Yamarkumi, Borno State	19.68	0.98	41.80	1.51	8.89	-
[3]Oghara, Delta State	30.46	0.50	50.92	0.19	2.70	0.70
[4]Tammah, Plateau State	27.48	0.11	56.43	0.03	-	
[5]Ekebedi, Abia State	28.03	-	58.53	0.2	1.41	0.03
*Fire Clay	25 – 45	< 2	55-75	< 1	0.5 – 2.0	-
**Refractory brick	25 - 44		51.70	0.10 - 20	0.5 – 2.4	-
#High Melting clay	16 -29	0.5 – 2.6	53 - 73	0.5 – 2.6	1 – 9	-

[1]Apeh et al.,(2011) [2] Abdullahi and Samaila, (2007) [3,5]Osaremwinda and Abel (2014) [4]Musa *et al.* (2012) [5]Odewale *et al.,* 2015 *Grimshaw (1971) **(Grimshaw, 1971; Abubakar *et al.,* 2014) *# Nnuka and Agbo (2000)

The result for chemical analysis in Table 1.0 shows a high silica content ranging of 54.27 and 58.31 % for both clay samples. The high silica content shows approximate consistency with the standard for fire-clay and quite with within the range for high melting clays as shown in Table 1. The result was impressively higher than 50.80, 41.80 and 50.92 % reported for Onibode, Yarmarkumi and Oghara clay in Ogun, Borno and Delta state of Nigeria. The result show that all the clay samples exist as quartz. The result suggests the suitability of these clays as a source of silica for the production of floor tiles.

The alumina content was determined to be 23.57 and 27.56 % for Wamakko and Illella clay samples. The results are appreciably with the standard specification of 25-45, 25 -44 and 16 -29 % for fireclay, refractory bricks and high melting clays (Grimshaw, 1971; Abubakar *et al.,* 2014). These values are also relatively consistent with the report of literature of clay sample analyzed in other region of the country as clearly depicted in Table 1. According to Abolarin *et al.* (2004) aluminium and silicon oxides are the important materials used in the manufacture of fire clay refractories. The sample analyzed in study has the requisite potential to be used for such purpose.

It is important to state that the percentages of basic oxides (CaO, MgO and Na_2O) were low. This explains plasticity characteristics of the clay. It was observed in this study that the compositions of all the major oxides do not sum up to 100 %. This discrepancy may be due to the presence of impurities in the clay. It can as well be attributed due to the traces of other ions (trace elements) such as copper, sulphur and zinc in the samples. Another possible reason

for this deficiency could be due to the presence of materials too infinitesimal for detection, such materials are expected to be removed during pre treatment stage.

Table 2.0: Physical Characteristics of Clay Samples

Clay Sample	Linear Shrinkage (%)	Bulk Density (g/cm^3)	Apparent Porosity (%)	Thermal Shock Resistance (cycles)	Refractories (^oC)	Cold Crushing Strength (MPa)	Loss On Ignition (%)
Wamakko	3.52	2.16	12.63	23	1669.07	12.56	15.07
Illela	13.53	3.14	23.26	26	1697.94	8.28	6.00
[1]Onibode, Ogun State	2.0	2.23	28.18	+30	1700	16	0.67
[2]Yamarkumi, Borno State	1.0	2.06	22.26	5	1400	15.43	14.05
[3]Oghara, Delta State	5.0	1.74	31.44	-	1500	9.88	12.18
[4]Tammah, Plateau State	7.41	3.10	30.69	22	1696	11.21	4.75
*Fire Clay	7-10	1.7-2.1	20-30	20-30	1500 - 1700	15	<15
**Siliceous fire clay	7-10	2.0	23.7	1	1500- 1600	15	
##Refractory brick		2.30	10 - 30	20 - 30	1430 - 1717	15	8 -18

*Grimshaw (1971) ** Omowumi (2000) ## (Grimshaw, 1971; Abubakar *et al.,* 2014) [1]Apeh *et al.*,(2011) [2] Abdullahi and Samaila, (2007) [3,5]Osaremwinda and Abel (2014) [4]Musa *et al.* (2012) [5]Odewale *et al.,* 2015

The bulk density is an important property in the transportation or handling of a refractory material. Bulk density is affected by a number of factors such as particle size, treatment process and the composition of the clay sample (Omotoyinbo & Oluwole, 2008). The standard bulk density for general refractory falls within the range of 1.7 - 2.1 g/cm^3 (Grimshaw, 1971) and 2.2 - 2.3 g/cm^3 for high alumina refractories (Amuda *et al.* 2005). Wamakko and and Illela clay sample had a bulk densities of 2.16 and 3.14 g/cm^3 respectively. Wamakko clay was consistent with this specification but Illela clay sample do not fall within these standard range as reported in Table 2. The high bulk density observed in these samples shows close proximity to 3.10 g/cm^3 reported for Tammah clay. This high bulk density might be attributed to the presence of impurities.

Loss on ignition (L.O.I) is a measure of amount of combustible volatile matter present in a clay (Abdullahi & Samaila, 2007).This value is a probable reflection of the finess and structure of the refractory. The L.O.I for both clay samples was determined to be 6.0 and 15.07 % for Illela and Wamakko clay sample. These values fall within the standard value of less than 15 % except for Wamakko that show slight deviation from the set specificification. However the L.O.I for this clay falls within the limit of 8-18 % for standard refractory brick (Grimshaw, 1971; Abubakar *et*

al., 2014). The result obtained in this study was higher than other reported work in some other part of the country as shown in Table 2.

Thermal shock resistance is the ability of sample to withstand heating and cooling several times before collapsing or the appearance of a visible crack (Folaranmi, 2009). Thermal shock of a refractory material must be high to withstand a wide variation in the operating temperature encountered in a furnace (Atanda *et al.,* 2012). Wamakko and Illela clay samples were found to have very good thermal shock resistance of 23 and 26 cycles respectively. This result shows appreciable consistency with 22 cycles reported for Tammah Clay (Musa *et al.,* 2012) and higher than 5 reported for Yarmarkumi clay (Abdullahi & Sumaila, 2007). The results also fall within the 20 -30 cycles specified for fireclay and refractory brick (Grimshaw, 1971; Abubakar *et al.,* 2014). The result revealed that both clay samples can withstand high temperatures before collapsing or losing it properties and therefore can be used for furnace linings.

The cold crushing strength is a measure of a material to withstand abrasion and load without breaking or disintegration (Muhammadu, 2013). The cold crushing strength were found to be 12.56 and 8.28 MPa for Wamakko and Illela, clay samples respectively. These values fall short of the standard values of 15 MPa for fireclay, refractory brick (Grimshaw, 1971).The values is also less than 15.93 and 16 MPa for Onibode and Yarmakumi clay samples reported in literature (Abdullahi & Sumaila, 2007; Apeh et al., 2011). Wamakko clay sample however exhibit a higher value of CCS than 9.88 and 11.21 MPa reported for Oghara and Tammah clay. This shows that the Wamakko clay samples can be used to transport slag.

Apparent porosity is the ability of the clay to be impermeable to gases and liquids. Porosity is used for measuring the degree of vitrification and it is directly related to shrinkage volume (Oloruntola *et al.,* 2010). The apparent porosity of 23.26 and 12.61 % were obtained for Illela and Wamakko clay samples respectively. The values for Illela were within the standard range of 20-30 % recommended for fireclay while Wamakko porosity of 12.61 % exhibits a shortfall of the stipulated standard. According to Aremu *et al.,* 2013 these effect associated thermal losses at elevated temperature. The author added that the thermal conductivity of a refractory materials decreases as its porosity increases as the pores tends to act as non conducting media. Low porosity of clay makes it's a good conductor of heat which makes it application in construction of oven smelting furnace (Isah, 2010). The results obtained for Wamakko and Mafara clay samples suggest its suitability for such purpose.

The linear shrinkage is a property of clay material which enables it's to resist structural changes and disintegration when subjected to heat (Folaranmi, 2009). Wamakko and Illela clay samples were found to have linear shrinkage of 3.52 and 8.24 % respectively. Illela clay samples conforms to the standard value of 7 to 10 % for fireclay. Wamakko donot conform to this standard but had higher value than 1 and 2 % reported by Apeh *et al.* (2011) and Abdullahi and Samaila, (2007) for Onibode and Yarmarkumi clay samples

Refractoriness is the maximum temperature a material can withstand after which it will fail (Folaranmi, 2009). The refractoriness of the rods could not be determined experimentally because the rods were fired to limited temperatures between 900 – 1100 ^{o}C. The values were estimated using Shuen's formula. The refractoriness of the clay samples was found to have softening temperature greater than 1500 ^{o}C which is in agreement with the relevant standard specification and literature.

Conclusion

The investigation carried out on the clay samples from Sokoto showed that the properties of the clays samples shows appreciable consistency with standard for fireclay and industrial refractory bricks except for some slight deviation. Results of chemical analysis clearly revealed that the clays are member of the alumina- silicate family and found to be suitable for use as fire- clay refractories. The refractorines the, clay samples were well above 1500 ^{o}C establishing their potential usage melting metals and non-metals with melting points below its refractoriness. The clay rods have very good crushing strength and satisfactory apparent porosity. The physico-chemical test revealed that the entire clay samples can be used for refractory purposes. Geological survey should be carried out to know the quantity of the clay deposit. Further research should be carried out on blending and the use of local additives and binders such as asbestos, graphite and rice husk to improve the physical and chemical properties of Wamakko clay samples with low qualities.

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ARTICLES AND RESEARCH REPORTS ON MATHEMATICS

MATHEMATICAL MODEL FOR EBOLA VIRUS TRANSMISSION DYNAMICS WITH QUARANTINE COMPARTMENT

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Abstract
We formulated a mathematical model for the dynamics of Ebola virus using a set of ordinary differential equations. We obtained both the disease free and disease endemic equilibria and analysed them for stability. Key to our analysis is the determination of the threshold, Effective Reproductive number (R_c)*. We found that the disease free equilibrium state is asymptotically stable when* $R_c \leq 1$ *, Further, we obtained the conditions for endemic equilibrium state of the model and some numerical results*

Keywords: Stability, Equilibrium State, Quarantine, Exposed, Endemic

Introduction
The first identified case of Ebola was on 26 August 1976, in Yambuku, a small rural village in Mongala District in northern Democratic Republic of the Congo (DCR) then known as Zaire Hewlett (2007). The first victim, and the index case for the disease, was village school headmaster Mabalo Lokela, who had toured an area near the Central African Republic border along the Ebola river between 12–22 August. On 8 September he died of what would become known as the Ebola virus. Subsequently a number of other cases were reported, almost all centered on the Yambuku mission hospital or having close contact with another case. 318 cases and 280 deaths (a 88% fatality rate) occurred in the DRC (King, 2008). The disease is endemic in some West African countries including, Sierra Loene, Liberia, Giunea (WHO, 2014).

Ebola is introduced into the human population through close contact with the blood, secretions, organs or other bodily fluids of infected animals. In Africa, infection has been documented through the handling of infected chimpanzees, gorillas, fruit bats, monkeys, forest antelope and porcupines found ill or dead or in the rainforest WHO (2014).
Ebola then spreads in the community through human-to-human transmission, with infection resulting from direct contact (through broken skin or mucous membranes) with the blood, secretions, organs or other bodily fluids of infected people, and indirect contact with environments contaminated with such fluids. Burial ceremonies in which mourners have direct contact with the body of the deceased person can also play a role in the transmission of Ebola. There is evidence that live Ebola virus can be isolated in semenal fliud of convalescent men for 82 days after onset of symptoms (WHO, 2014) hence a pointer to sexsual transmission.

Ebola virus disease (EVD) is a severe acute viral illness often characterized by the sudden onset of fever, intense weakness, muscle pain, headache and sore throat. This is followed by vomiting, diarrhoea, rash, impaired kidney and liver function, and in some cases, both internal

and external bleeding. The incubation period, that is, the time interval from infection with the virus to onset of symptoms, is 2 to 21 days WHO (2014) .
Ebola virus infections can be diagnosed definitively in a laboratory through several types of tests: antibody-capture enzyme-linked immunosorbent assay (ELISA), antigen detection tests, serum neutralization test, reverse transcriptase polymerase chain reaction (RT-PCR) assa, electron microscopy, virus isolation by cell culture, etc. No licensed vaccine for EVD is available. Several vaccines are being tested, but none are available for clinical use, and no specific treatment is available. New drug therapies are being evaluated.

Mathematical model has been an important tool in analyzing the spread and control of infectious diseases. The first of such models was credited to Daniel Bernoulli in 1760, the aim of his model was to evaluate the impact of variolation or inoculation on healthy people with smallpox virus Hethcote (2000). This was followed by Hamer (1906) model on measles, Rose (1911) model on malaria, and the famous Kermack and Mckendrick (1927) SIR model for the transmission of disease in a closed population. The past century has witnessed rapid development of mathematical models to understand the dynamics of infectious diseases.

Abdon &Emile (2014), constructed a model describing the spread of the deadly disease called Ebola hemorrhagic fever. The model was first constructed using the classical derivative and then converted to the generalized version using the beta derivative. He studied in detail the endemic equilibrium points and provided the Eigen values associated using the Jacobian method.

The study showed that, for small portion of infected individuals, the whole country could die out in a very short period of time in case there is no good prevention. Zach (2012) represented the transmission of Ebola virus using a modified Susceptible – Infected – Recovered (SIR) disease model. The model had four compartments, $S(t)$, $I(t)$, $R(t)$, and $D(t)$ representing the Susceptible, Infective, Recovered and the Deceased compartment. The parameters of the model are a the rate of infection, b the rate of recovery, c the rate of Susceptibility, e the rate of death.

Similarly other recent models Gomes (2014), Fisman (2014), Althaus(2014) centered on the estimation of basic reproduction number, a key threshold in disease control but lack other further mathematical analysis

Materials and Methods

Model Formulation

We represented the dynamics of Ebola virus using a set of differential equation. We divided the human population into 5 compartments as shown below:
In formulating our model we made the following assumptions; The infection is from, Infectious and Quarantine individual to Susceptible. The transmissibility from Quarantine Class is weighted using η. The model assumed that individuals move both from only Infectious and Quarantine to Removed class upon recovery from the virus, while Exposed individual move to Infectious class. The researcher assumed that recovered individual remain immune therefore do not go back to Susceptible class.

$$\frac{dS}{dt} = a - \frac{\beta(I + \eta Q)S}{N} - \mu S \qquad (1)$$

The equation (1) above for susceptible population is generated *via* recruitment of humans by birth or immigration into the community at a constant rate a. This population is decreased following infection, which can be acquired *via* contact with member(s) of exposed, infectious or quarantine population at a rate β and by natural death at the rate μ. η is a weight factor for infection from quarantine to susceptible population, this becomes necessary as movement is restricted in the quarantine center.

$$\frac{dE}{dt} = \frac{\beta(I+\eta Q)S}{N} - (\mu+\sigma)E \qquad (2)$$

The equation (2) above for exposed population is generated when there is effective contact between the susceptible and any member of, infectious or quarantine population and the susceptible population. The population is decreased by natural death at the rate μ, and by progression rate to the infectious class at the rate σ

$$\frac{dI}{dt} = \sigma E - (\alpha + \gamma_1 + \mu + \delta)I \qquad (3)$$

The equation (3) above for Infected population is generated as the exposed class develops symptoms and become infectious at the rate σ , the population is decreased by natural death, death due to infection, recovery and migration to quarantine center at the rate $\mu, \delta, \gamma_1,$ and γ_2 respectively.

$$\frac{dQ}{dt} = \alpha I - (\mu + \delta + \gamma_2)Q \qquad (4)$$

The equation (4) above for quarantine population is generated as members of the exposed class migrate to quarantine center at the rate α and is decreased by natural death, death due to infection and as members of the infectious population recover from the virus as a result of treatment at the rate $\mu, \delta, \gamma_2,$ respectively

$$\frac{dR}{dt} = \gamma_1 I + \gamma_2 Q - \mu R \qquad (5)$$

The equation (5) above is generated via recovery from infectious and quarantine population at the rate γ_1, and γ_2 and is reducedby natural death μ.

Thus the dynamics of the ebola virus can be represented by the following set of ordinary differential equation:

$$\frac{dS}{dt} = a - \frac{\beta(I+\eta Q)S}{N} - \mu S$$
$$\frac{dE}{dt} = \frac{\beta(I+\eta Q)S}{N} - (\mu+\sigma)E$$
$$\frac{dI}{dt} = \sigma E - (\alpha+\gamma_1+\mu+\delta)I \qquad (6)$$
$$\frac{dQ}{dt} = \alpha I - (\mu+\delta+\gamma_2)Q$$
$$\frac{dR}{dt} = \gamma_1 I + \gamma_2 Q - \mu R$$

Where $S(t), E(t), I(t), Q(t), R(t)$ denote the number of Susceptible, Exposed, Infectious, Quarantine, and Removed population at time t respectively. And
$N(t) = S(t) + E(t) + I(t) + Q(t) + R(t)$
Such that
$$\frac{dN}{dt} = a - \mu N - \delta(I+Q) \qquad (7)$$

Parameters of the Model Equation are:
a – recruitment rate which includes birth and immigration
β – the effective contact rate
η – weight for the assumed reduction in transmissibility of Quarantine class
μ – natural mortality rate
σ – progression rate from Exposed to Infectious class
δ – death rate due to Infection
γ_1 – recovery rate from Infectious class
γ_2 – recovery rate from Quarantine class due to treatment
α – the rate at which infected are being quarantined

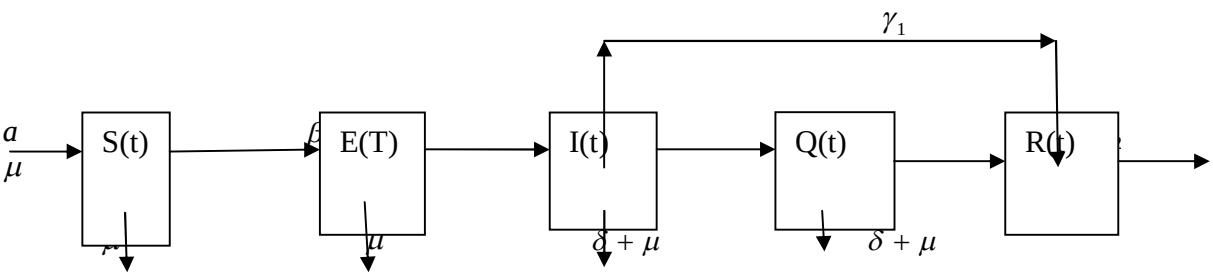

Figure 1: Schematic diagram of the model

Model Analysis

In this section, the basic dynamical features of the model (1) to (5) will be explored. We claim the following:

Lemma 1 *The closed set*

$$D = \left\{ (S, E, I, Q, R) \in \Re_+^5 : S + E + I + Q + R \le \frac{a}{\mu} \right\}$$

is positively invariant and attracting with respect to the basic model equations (1) to (5).

Proof

Adding all the equations of (6) gives

$$\frac{dN}{dt} = a - \mu N - \delta(I + Q) \qquad (7)$$

Since $\frac{dN}{dt} < a - \mu N$, It follows that $\frac{dN}{dt} < 0$ if, $N(t) > \frac{a}{\mu}$

Thus a standard comparison theorem, Lakshmikantham (1989) can be used to show that $N(t) < N(0)e^{-\mu(t)} + \frac{a}{\mu}\left[1 - e^{-\mu(t)}\right]$. In particular, $N(t) \le \frac{a}{\mu}$ if $N(0) \le \frac{a}{\mu}$. Thus, D is positively invariant. Further, if $N(t) > \frac{a}{\mu}$, then either the solution enters D in finite time or $N(t)$ approaches $\frac{a}{\mu}$, and the infected variables I, Q approaches zero. Hence , D is attracting i.e (all solutions $\Re_+^5$ eventually enters D). Thus in D, the basic model (6) is well posed epidemiologically and mathematically, Hethcote (2000). Hence, it is sufficient to study the dynamics of the model equations in D

Existence and Stability of Equilibrium State

The system has two possible equilibria in D where,

$$D = \left\{ (S, E, I, Q, R) \in \Re_+^5 : S + E + I + Q + R \le N \right\}$$

Disease free Equilibrium State

At equilibrium state, the rate of change of the state variables is zero. The disease free equilibrium of our model equations (6) gives

$$E_0 = \left(\frac{a}{\mu}, 0, 0, 0, 0 \right) \qquad (8)$$

The stability of this disease free equilibrium given by equation (8) will be analyzed via the basic reproductive number

The Effective Reproductive Number (R_c)

One of the most important concerns about any infectious disease is its ability to invade a population. Many epidemiological models have a disease free equilibrium (DFE) at which the population remains in the absence of the disease. These models usually have a threshold parameter, known as the basic reproductive number R_c such that when $R_c \le 1$, then the DFE is locally asymptotically stable, and the disease cannot invade the population, but if $R_c > 1$,then the DFE is unstable and invasion is always possible see Hethcote (1978).

We define the basic reproductive number R_c as the number of secondary infections that one infective individual would create over the duration of the infectious period provided that everyone else is susceptible. Our model is suited for a heterogeneous population in which the vital and epidemiological parameter for an individual may depend on such factors as the stage of the disease, spatial position, etc. however, we assume that the population can be broken into homogeneous subpopulation or compartment such that individual in a given compartment are indistinguishable f rom one another.

We use the next generation matrix approach as described by Driessch and Watmough (2005) to derive our Basic Reproductive Number R_0. Numerous other articles Dietz (1993), Roberts (2003), and Diekmann (1990), are devoted to the calculation of basic reproductive number R_c for different models of various diseases.

Here, the basic reproductive number R_c is the spectral radius (dominant eigenvalue) of the product matrix
FV^{-I}, i.e $R_c = \rho(FV^{-I})$
Our model has three Infective compartments namely the, Exposed E, Infectious I and Quarantine Q compartments. It follows that the matrices F and V for the new infective terms and remaining transfer terms respectively are given below. Where the entries of F and V are partial derivatives of $f_i(x)$ and $v_i(x)$. For our model, F and V are given below.

$$F = \begin{bmatrix} 0 & \frac{\beta}{N} & \frac{\eta\beta}{N} \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix} \tag{9}$$

$$V = \begin{bmatrix} -(\mu+\delta) & 0 & \frac{\eta\beta}{N} \\ 0 & -(\alpha+\gamma_1+\mu+\delta) & 0 \\ 0 & \alpha & -(\mu+\gamma_2+\delta) \end{bmatrix} \tag{10}$$

$$R_0 = \frac{\beta\sigma}{(\mu+\delta)(\alpha+\gamma_1+\mu+\delta)(\mu+\gamma+\delta)} \tag{11}$$

Lemma 2. The disease free equilibrium is locally asymptotically stable if
$R_c < 1$

Proof
We prove lemma 2 by showing that the Jacobian matrix of the system (6) have positive eigen values at the disease free equilibrium
The Jacobian Matrix of our model equations (6) is given by

$$J=\begin{bmatrix} \frac{-\beta((I+\eta Q)+\mu)}{N} & 0 & \frac{-\beta S}{N} & \frac{-\eta\beta S}{N} & 0 \\ \frac{\beta(I+\eta Q)}{N} & -(\mu+\delta) & \frac{\beta S}{N} & \frac{\eta\beta S}{N} & 0 \\ 0 & \sigma & -(\alpha+\gamma_1+\mu+\delta) & 0 & 0 \\ 0 & 0 & \alpha & -(\mu+\delta+\gamma_2) & 0 \\ 0 & O & \gamma_1 & \gamma_2 & -\mu \end{bmatrix} \quad (12)$$

At disease free equilibrium the Jacobian matrix becomes

$$J=\begin{bmatrix} -\mu & 0 & \frac{-\beta S^*}{N} & \frac{-\eta\beta S^*}{N} & 0 \\ 0 & -(\mu+\delta) & \frac{\beta S^*}{N} & \frac{\eta\beta S^*}{N} & 0 \\ 0 & \sigma & -(\alpha+\gamma_1+\mu+\delta) & 0 & 0 \\ 0 & 0 & \alpha & -(\mu+\delta+\gamma_2) & 0 \\ 0 & O & \gamma_1 & \gamma_2 & -\mu \end{bmatrix} \quad (13)$$

The characteristic equation of equation (13) is given by

$$J=\begin{bmatrix} -(\mu+\lambda) & 0 & \frac{-\beta S^*}{N} & \frac{-\eta\beta S^*}{N} & 0 \\ 0 & -((\mu+\delta)+\lambda) & \frac{\beta S^*}{N} & \frac{\eta\beta S^*}{N} & 0 \\ 0 & \sigma & -(\alpha+\gamma_1+\mu+\delta+\lambda) & 0 & 0 \\ 0 & 0 & \alpha & -(\mu+\delta+\gamma_2+\lambda) & 0 \\ 0 & 0 & \gamma_1 & \gamma_2 & -(\mu+\lambda) \end{bmatrix} \quad (14)$$

The eigenvalues of equation (14) is given by

$\lambda_1=-\mu$

$\lambda_2=-(\mu+\delta)$

$\lambda_3=-(\alpha+\gamma_1+\mu+\delta)$

$\lambda_4=-(\mu+\delta+\gamma_2)$

$\lambda_5=-\mu$

From our evaluations we found that $\lambda_3<0$, when $R_c<1$ where

$$R_0=\frac{\beta\sigma}{\mu(\mu+\delta)^2(\alpha+\gamma+\mu+\delta)}$$

For local stability of disease free equilibrium, Routh-Hurwitz criteria requires that all eigenvalues have negative real part. Since all the eigenvalues of equation (14) have negative real part, the disease free equilibrium is locally asymptotically stable

Lemma 3. The disease free equilibrium is globally asymptotically stable (GAS)

Proof

Consider the Lyapunov function

$$F=A_3A_2E+A_1A_3I+A_1A_2Q$$

where $A_1 = (\mu + \sigma)$

$A_2 = (\alpha + \gamma_1 + \mu + \delta)$

$A_3 = (\mu + \delta + \gamma_2)$

The Lyapunov derivative is given by (where a dot represents differentiation with respect to time, t) is given by:

$$\dot{F} = A_3 A_2 \dot{E} + A_1 A_3 \dot{I} + A_1 A_2 \dot{Q}$$

$$= A_3 A_2 \left[\left(\frac{\beta I + E + \eta Q}{N} \right) S - A_1 E \right] + A_1 A_3 [\sigma E - A_2 I] + A_1 A_2 [\alpha I - A_3 Q]$$

$$= \left[\frac{A_3 A_2 \beta I S}{N} + \frac{A_3 A_2 E S}{N} + \frac{A_3 A_2 \eta Q S}{N} - A_3 A_2 A_1 E \right] + [A_1 A_3 \sigma E - A_1 A_3 A_2 I] + [A_1 A_2 \alpha I - A_1 A_2 A_3 Q]$$

$$= \left[\frac{A_3 A_2 S}{N} - A_3 A_2 A_1 + A_1 A_3 \sigma \right] E + \left[\frac{A_3 A_2 \beta S}{N} - A_1 A_3 A_2 + A_1 A_2 \alpha \right] I + \left[\frac{A_3 A_2 \eta S}{N} - A_1 A_2 A_3 \right] Q$$

$$= \frac{A_3 A_2 S}{N} \{ (1 - A_3 A_2 A_1 + A_1 A_3 \sigma) E + (\beta - A_1 A_3 A_2 + A_1 A_2 \alpha) I + (\eta - A_1 A_2 A_3) Q \}$$

Since

$S \le S^* \le \frac{A_3 A_2}{N} \{ (1 - A_3 A_2 A_1 + A_1 A_3 \sigma) R_c E + (\beta - A_1 A_3 A_2 + A_1 A_2 \alpha) R_c I + (\eta - A_1 A_2 A_3) R_c Q \}$ Thus, $\dot{F} \le 0$ if $R_0 \le 1$, with $\dot{F} = 0$ if and only if $E = I = Q$. Further, the largest compact invariant set in is the singleton $\{E_0\}$. It follows from Lasalle invariant principle (chapter 2) ,theorem 6.4 of Lasalle (1976) that every solution to the model equations (6) with invariant condition in D converges to the DFE E_0 as $t \to \infty$ that is $E(t), I(t), Q(t) \to (0,0,0)$ as $t \to \infty$. Substituting $E = I = Q = 0$ into equations (2), (3) and (4) gives $S(t) \to S^*$ as $t \to \infty$. Thus, $[S(t), E(t), I(t), Q(t), R(t)] \to [0,0,0]$ as $t \to \infty$ for $R_0 \le 1$, so that the E_0 is GAS in D if $R_0 \le 1$

Existence and Stability of Endemic Equilibrium State

In order to find the endemic equilibrium of the our model equations given by equations (6) i.e. equilibria where at least one of the infected components of the model is non zero, the following steps are taken. We let $E_1 = (S^*, E^*, I,^* Q^*, R^*)$ represent any arbitrary endemic equilibrium of our model equations (6). Further, let

$$\pi = \frac{\beta(I + \eta Q)}{N} \tag{15}$$

Be the force of infection at steady state. Substituting (15) into equations (6) and solving at steady state, we have

$$S^* = \frac{a}{(\pi - \mu)} \tag{16}$$

$$E^* = \frac{a\pi}{(\pi - \mu)(\mu + \delta)} \tag{17}$$

$$I^* = \frac{a\pi\sigma}{(\pi - \mu)(\mu + \delta)(\alpha + \gamma_1 + \mu + \delta)} \tag{18}$$

$$Q^* = \frac{a\pi\sigma\alpha}{(\pi-\mu)(\mu+\delta)(\alpha+\gamma_1+\mu+\delta)(\mu+\delta+\gamma_2)} \quad (19)$$

$$R^* = \frac{a\pi\sigma\gamma_1(\pi-\mu)(\mu+\delta)(\mu+\delta+\gamma_2)A+\gamma_2\alpha a\pi(\pi-\mu)(\mu+\delta)A}{(\pi-\mu)(\mu+\delta)(\mu+\delta+\gamma_2)A^2} \quad (20)$$

where

$$A = (\alpha+\gamma_1+\mu+\delta) \quad (21)$$

Substituting equations (15) to (19) into equation (14) gives

$$\pi = \frac{\beta\left(\frac{a\pi\sigma}{(\pi-\mu)(\mu+\delta)A}+\frac{a\pi}{(\pi-\mu)(\mu+\delta)}+\eta\frac{a\pi\sigma\alpha}{(\pi-\mu)(\mu+\delta)(\mu+\delta+\gamma_2)A}\right)}{N} \quad (22)$$

$$\pi = \beta\left(\frac{a\pi\sigma(\mu+\delta+\gamma_2)+a\pi(\mu+\delta+\gamma_2)A+\eta a\pi\sigma\alpha}{(\pi-\mu)(\mu+\delta)(\mu+\delta+\gamma_2)AN}\right) \quad (23)$$

$$\pi(\pi-\mu)(\mu+\delta)(\mu+\delta+\gamma_2)AN = \beta a\pi\left(\sigma(\mu+\delta+\gamma_2)+(\mu+\delta+\gamma_2)A+\eta\sigma\alpha\right) \quad (24)$$

$$\pi(\pi-\mu)(\mu+\delta)(\mu+\delta+\gamma_2)AN - \beta a\pi\left(\sigma(\mu+\delta+\gamma_2)+(\mu+\delta+\gamma_2)A+\eta\sigma\alpha\right) = 0 \quad (25)$$

$$\pi^2 - \pi\mu(\mu+\delta)(\mu+\delta+\gamma_2)AN - \beta a\pi\left(\sigma(\mu+\delta+\gamma_2)+(\mu+\delta+\gamma_2)A+\eta\sigma\alpha\right) = 0 \quad (26)$$

$$\pi^2 - \pi\left\{\mu(\mu+\delta)(\mu+\delta+\gamma_2)AN + \beta a\left(\sigma(\mu+\delta+\gamma_2)+(\mu+\delta+\gamma_2)A+\eta\sigma\alpha\right)\right\} = 0 \quad (27)$$

For

$$a_0 = 1$$

$$b_0 = \mu(\mu+\delta)(\mu+\delta+\gamma_2)AN$$

$$c_0 = \beta a\left(\sigma(\mu+\delta+\gamma_2)+(\mu+\delta+\gamma_2)A+\eta\sigma\alpha\right)$$

Equation (27) becomes (28)

$$a_0\pi^2 - b_0\pi + c_0 = 0$$

It can be shown that the non-zero equilibria of the model (6) satisfy the following quadratic (28). Solving the quadratic equation (28) for π and substituting into equations (16) to (20) gives the explicit values of the endemic equilibrium $E_1 = \left(S^*, E^*, I,^* Q^*, R^*\right)$. Clearly, the coefficient a_0 of (28), is always positive, and c_0 is positive (negative) if R_c is less than (greater than) unity, respectively. Thus, the following result is established.

Theorem 1 The Ebola model (6) has:

(i) a unique endemic equilibrium if ; $c_0 < 0 \Leftrightarrow R_c > 1$

(ii) a unique endemic equilibrium if $b_0 < 0$, and $c_0 = 0$ or $b_0^2 - 4a_0c_0 = 0$

(iii) two endemic equilibria if $c_0 < 0$, $b_0 < 0$, and $b_0^2 - 4a_0c_0 > 0$

Result and Discussion

Variables and Parameters Values

Table 1: Parameter values and initial conditions

Parameters	Values
a	0.3
β	0.016
η	0.001
μ	0.2
σ	8
δ	0.6
γ_1	0.3
γ_2	0.4
α	2
S	1000
E	0
I	10
Q	0
R	0

Note: The values in table 1 above are hypothetical but however, are in line with some reported cases

Numerical Simulation

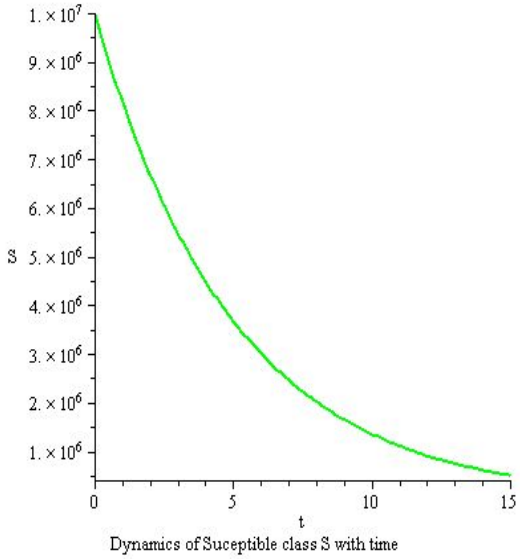

Figure 1:

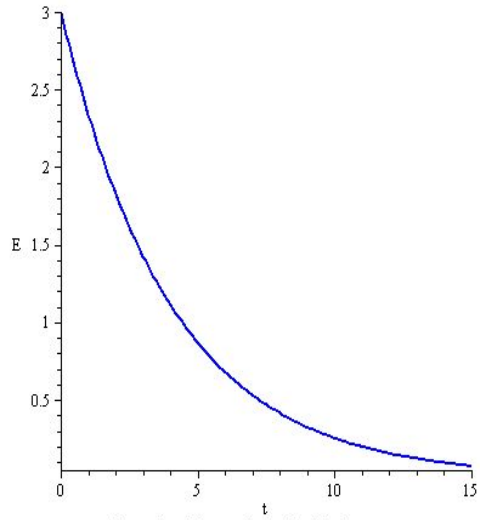

Figure 2: Dynamics of Exposed class E with time

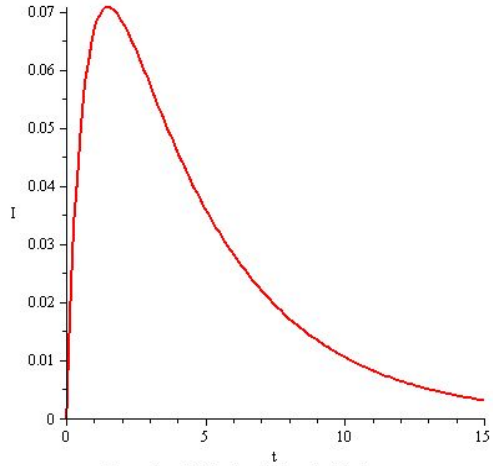

Figure 3: Dynamics of theInfected class I, with time

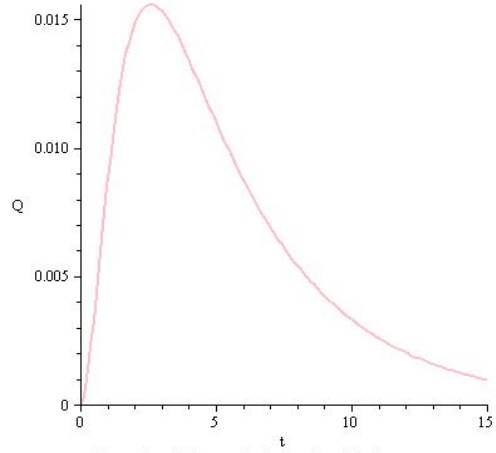

Figure 4: Dynamics of Quarantined class Q , with time

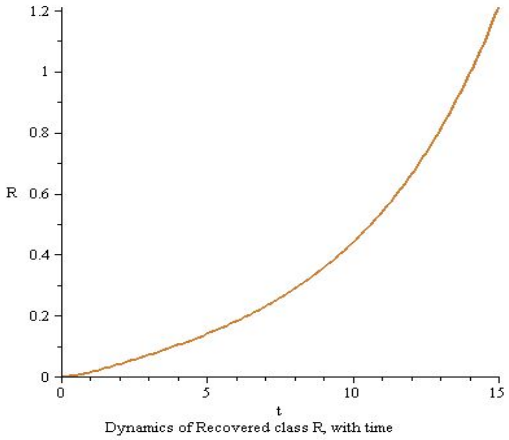

Figure 5:

The parameter values for the graph are as shown in table 1 above.

Discussion

Figures 1 to 5 are numerical simulation of the Ebola virus model given by equations (1) to (5), using the original system variables with parameter values and initial condition as given in table 1 the simulations were conducted using the Runge-Kuta method (rkf45) embedded in Maple 13. The rkf45 method is a fourth-order method, meaning that the local truncation error is on the order of $0(h^5)$, while the total accumulated error is order $0(h^4)$. Figure 1 shows that the susceptible population is on the decrease, this is expected since infection is decreasing parameter of the population. Figure 2 shows that the Exposed class tends to zero within small time, this is in line with epidemiology and our assumption since members either progress to the Infected class or are out of the population due to natural death. Figure 3 shows that the Infected class first increases, then begins to decline as a result of quarantine, recovery, or death due to infection. Figure 4 shows that the quarantine class has similar behavior with the Infected class. Figure 5 shows that the Recovered population is increasing. The figures 1 to 5 confirms the asymptotic stability of the disease free equilibrium.

Conclusion and Recommendation

Conclusion

In this paper a deterministic mathematical model for the dynamics of Ebola Virus was formulated. The model incorporated a Quarantine compartment, and the rate of transmission from the quarantined to the susceptible was weight as a result of restriction of movement imposed on the quarantined territory. We first showed that our model is epidemiologically and mathematically well posed. Further, we obtained both the disease and endemic equilibria and analyzed them for stability. It was established that the disease free equilibrium is both locally and globally stable.

Recommendation

The numerical results show that the susceptible population approaches zero within a short period of time in the absence of control. We therefore recommend high rate of quarantining and tretment which will help stablise the population.The model should be investigated for possibility of backward bifurcation as indicated by case (iii) of theorem 1. We recommend the

inclusion of the vector population to give a comprehensive understanding of the transmission dynamics.

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DETERMINING THE BEST MODEL ON THE EFFECT OF OVERWEIGHT ON ADULT INDIVIDUAL USING MULTIPLE REGRESSION ANALYSIS

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Abstract
This study examine the best model that determine the effect of overweight on adult individuals using multiple regression analysis. One hundred and sixty (160) healthy individuals were used for the study, and the variables of interest were Age, Sex, and Height. The multiple regression analyses were carried out to determine the best model that estimate the overweight of an adult individual using the variables of interest. The data were collected using digital scale for measuring subject's weight, meter rule for measuring subject's height to the nearest 0.00m. Percentage distribution of the body weight categories of the subjects based on Body Mass Index (BMI); 45% of the subjects were at abnormal weight that is (underweight 3%, overweight 32% and obese 10%), and normal weight 55%.The study indicates that weight can serve as a positive indicator of studying overweight in the selected communities; and the Multiple regression equation $\hat{y} = -0.548 + 0.213(Age) + 35.833(Height) - 0.913(Sex)$ *was the best model. However, it may not be used to determine underweight in adults. Regular BMI and weight screening is recommended as an easy and effective means of assessing body weight and in the prevention of weight related diseases in adults.*

Keywords: Overweight, BMI, Regressing, Underweight and Obese

Introduction
The term body weight is used in the biological and medical sciences; it is referred to as a person's mass. The human Body weight is measured in kilograms. Measurement of mass or weight is in kilogram throughout the world, except for some countries such as United States which used pounds in measuring weight. Also in United Kingdom units like stones and pounds are used in measuring weight (Robinson e tal, 1983).

The human body weight is the mass of a person taken without any items on, but practically it is negligible to take the human body weight with clothes on but often without the shoes and heavy accessories like phones, jewelries, wrist watches and wallet. Body weight is one way of determining a person's health.Ideal Body Weight was initially introduced by Devine in1974 to allow estimation of drug clearances in obese patients.

In this paper measurements of weight, height, age, and gender were collected and the experiment designed was to determine the best model that fitted the determination of overweight and whether or not there exist a relationship between the Ideal Body Weight for any individuals given his/her height, age and gender (Sex)..
Many Nigerians do not care about knowing their weight and what exactly they should weight, research has shown that this happened not because they have no access to scale, but rather

they are not just interested in measuring their weights. Over weight don't just occur but it started from a stage that many Nigerians don't know due to their negligence to weight measurement. Many Nigerians have lost their life to overweight because they do not know they are overweighing. The goal of this study is to help adults to know his/her weight by simple computation and estimation without climbing a scale or the use of other measuring devices.

However, there is no variable for measuring human fatness, but weight can be measured as it is a body mass. As such one cannot say is at normal weight, underweight or overweight without relating weight to the factor variables (height, age and gender).

Review on Overweight and Obesity

Overweight is a common chronic ailment, from 20 to 50per cent of adults in the United States are overweight (Stewart 1980). Most research on the effects of being overweight has focused on the relationship between being overweight and the prevalence of various chronic diseases, such as diabetes and heart disease, or on premature mortality.

According to WHO (2000), in recent years, occurrence of Overweight and obesity are very high affecting both developed and developing countries like India. In the works of James, Leach, Kalamara and Shayeghi (2004). Obesity is associated with a large number of debilitating and life threatening disorders, such as cardiovascular, metabolic and other non-communicable diseases.The causes of adult obesity include a variety of factors like diet, genetic predisposition, lack of physical activities and other behavioral factors.

According to Wilborn, Beckham, Jequier and Tappy (2005) the prevalence of obesity is increasing worldwide and it has become a significant health hazard. Obesity rates have now reached epidemic proportions in the western hemisphere constituting over 25% of population in US and 15% in Europe.

Prevalence of obesity in India is up to 50% inwomen and 32.2% among Men in the upperstrata of the society. In Delhi, the prevalence of obesity is 33.4% in urban women and 21.3% in Men according to Gopinath, Chadha, Jain, Shekhawat, Tandon (1994). Obesity and overweight are not only a problem of adults but also of the children and adolescents worldwide. Even in famine stricken country like Ethiopia 25% of adolescents werefound to be obese. In India little attention has been paid to childhood and adolescent obesity until recently, Jugesh Chhatwal (2004).Studies on medical students and health personnel in many countries, suggest that obesity is a problem among these population groups11-15. Overweight and obesity have been considered a serious health problem worldwide since 1997 (WHO, 2000). Both developed and developing countries are experiencing increasing rates of overweight and obesity. Overweight and obesity are the fifth leading risk for global deaths; at least 2-8 million adults die each year as a result of being overweight or obese. In addition, 44% of the diabetes burden, 23% of the ischemic heart disease burden, between 7% and 41% of certain cancer burdens are attributable to overweight and obesity. Once considered a high-income country problem, overweight and obesity are now on the rise in low – and middle-income Countries, particularly in urban settings. Close to 35 million overweight children are living in developing countries and 8 million in developed countries. Overweight and obesity are linked to more deaths worldwide than underweight. For example, 65% of the world's population live in countries were overweight and obesity kill more people than underweight (this include the high income and most middle-income countries) (WHO May, 2012).

Nigeria is witnessing both demographic and epidemiologic transitions and these could be some of the possible reasons why the prevalence of non-communicable diseases is increasing (Adeyemo, Luke, Cooper, Wu, Tayo, Zhu, Rotimi, Bouzekri, and Ward, 2003). There is a general misconception in Nigeria that obesity is a sign of affluence (Adeyemo et al 2003).

Ojofeitimi etal (2007) found that 21.2% of their respondents were obese, while Kadiri, Salako (2007) and Adeogun (2011) also found obesity in 21% and 28% of males and females respectively in a study of 146 middle-aged Nigerians. Similarly, Ben-Bassey, Oduwole and Ogundipe (2007), observed that in many of the urban centers of the developing Countries, a change in lifestyle due to increased affluence has been observed, and this change in lifestyle is an important factor in the global epidemic of overweight and obesity. Also as observed by Adeogun, Setonji and Owoyemi (2010), the obesity epidemic is especially evident in industrialized nations where many people live sedentary lives and eat more convenience foods, which are typically high in calories and low in nutritional value.

Obesity is a medical condition in which excess body fat has accumulated to the extent that it may have an adverse effect on health (WHO, 2000). Obesity increases the likelihood of various diseases, particularly heart disease, type 2 diabetes, breathing difficulties during sleep, certain types of cancer and osteoarthritis.(Wilborn e tal, 2005).

Pieniak, etal (2009), a BMI of 30-35 reduces life expectancy by two to four years, while severe obesity (BMI>40) reduces life expectancy by 10 years. Like many other medical conditions, obesity is the result of interplay between genetic and environmental factors(Whitlock et al., 2009). The percentage of obesity that can be attributed to genetics varies, depending on the population examined, from 6-85%. An individual level, a combination of excessive caloric intake and a lack of physical activity are thought to explain most cases of obesity (Ogden et al., 2007). A limited number of cases are due primarily to genetics, medical reasons, or psychiatric illness. In contrast, increasing rates of obesity at a societal level are felt to be due to an easily accessible and palatable diet. (Sodjinou, 2000; James, 2004).

Abbate e tal (2006). identified ten other possible contributors to the recent increase of obesity: (1) insufficient sleep, (2) endocrine disruptors (environmental pollutants that interfere with lipid metabolism), (3) decreased variability in ambient temperature, (4) decreased rates of smoking, because smoking suppresses appetite, (5) increased use of medications that can cause weight gain (e.g. atypical antipsychotics), (6) proportional increases in obesity ethnic and age groups that tend to be heavier, (7) pregnancy at a later age (which may cause susceptibility obesity and family background.to obesity in children), (8) epigenetic risk factors passed on generationally, (9) natural selection for higher BMI and (10) Assortative mating leading to increased concentration of obesity risk factors (this would not necessarily increase the number of obese people, but would increase the average population weight).

Some Causes of Overweight and Obesity

Overweight and obesity happen over time when you take in more calories than you use.According to WHO many Americans aren't very physically active. One reason for this is that many people spend hours in front of TVs and computers doing work, Schoolwork, and leisure activities. In fact, more than 2 hours a day of regular TV viewing time has been linked to overweight and obesity. Other reasons for not being active include: relying on cars instead of

walking, fewer physical demands at work or at home because of modern technology and conveniences, and lack of physical education classes in Schools. People who are inactive are more likely to gain weight because they don't burn the calories that they take in from food and drinks. An inactive lifestyle also raises your risk for coronary heart disease, high blood pressure, diabetes, colon cancer, and other health problems.

Our environment doesn't support healthy lifestyle habits; in fact, it encourages obesity. Some reasons include:Lack of neighborhood sidewalks and safe places for recreation. Not having area parks, trails, sidewalks, and affordable gyms makes it hard for people to be physically active work schedules. People often say that they don't have time to be physically active because of long work hours and time spent commuting. Overweight and obesity tend to run in families. Your chances of being overweight are greater if one or both of your parents are overweight or obese (National Institutes of Health, NIH, 2012).Your genes also may affect the amount of fat you store in your body and where on your body you carry the extra fat. Because families also share food and physical activity habits, a link exists between genes and the environment.

Children adopt the habits of their parents. A child who has overweight parents who eat high-calorie foods and are inactive will likely become overweight too. However, if the family adopts healthy food and physical activity habits, the child's chance of being overweight or obese is reduced.

Some hormone problems may cause overweight and obesity, such as underactive thyroid (hypothyroidism), Cushing's syndrome, and polycystic ovarian syndrome (PCOS).Underactive thyroid is a condition in which the thyroid gland doesn't make enough thyroid hormone and lack of thyroid hormone will slow down your metabolism and cause weight gain. You'll also feel tired and weak.

Cushing's syndrome is a condition in which the body's adrenal glands make too much of the hormone cortisol. Cushing's syndrome also can develop if a person takes high doses of certain medicines, such as prednisone, for long periods.People who have Cushing's syndrome gain weight, have upper-body obesity, a rounded face, fat around the neck, and thin arms and legs.

Certain medicines may cause you to gain weight. These medicines include some corticosteroids, antidepressants, and seizure medicines. These medicines can slow the rate at which your body burns calories, increase your appetite, or cause your body to hold on to extra water. All of these factors can lead to weight gain.
Some people eat more than usual when they're bored, angry, or stressed. Over time, overeating will lead to weight gain and may cause overweight or obesity. While some gain weight when they stop smoking. One reason is that food often tastes and smells better after quitting smoking. Another reason is because nicotine raises the rate at which your body burns calories, so you burn fewer calories when you stop smoking. However, smoking is a serious health risk, and quitting is more important than possible weight gain.

As you get older, you tend to lose muscle, especially if you're less active. Muscle loss can slow down the rate at which your body burns calories. If you don't reduce your calorie intake as you get older, you may gain weight. Midlife weight gain in women is mainly due to aging and lifestyle, but menopause also plays a role. Many women gain about 5 pounds during menopause and have more fat around the waist than they did before.During pregnancy, women

gain weight to support their babies' growth and development. After giving birth, some women find it hard to lose the weight. This may lead to overweight or obesity, especially after a few pregnancies.

Material and Methods

This study was carried out between August and September, 2014 at Zone A, B and C, that is Minna, Bida and Kontagora in Niger state, Nigeria. A total of 160 healthy subjects, aged between 18 and 65 years were randomly selected for the study. A simple random sampling technique was used to select the subject and none of the female subjects was pregnant at the period of the study. After obtaining their consent the age, sex, height (m) and weight (kg) of the subject were recorded.Weight was measured using digital balance to the nearest whole number (0kg) ensuring that the subject is not putting on heavy objects. Height was measured using meter rule to the nearest 0.01 meter with the subject standing upright, barefooted, without cap or headgear. Body Mass Index was defined according to WHO cut-offs as follows:Underweight as 18.4kg/m^2 or below;Normal weight as 18.5kg/m^2 – 24.9kg/m^2;Overweight as 25.0kg/m^2 – 29.9kg/m^2;Obese as BMI of 30kg/m^2 or greater.BMI was calculated as weight (kg)/height (m^2).

Regression analysis is widely used for prediction and forecasting, where it is used as substantial overlap with the field of machine learning. The performance of regression analysis methods in practice depends on the form of the data generating process, and how it relates to the regression approach being used. Since the true form of the data-generating process is generally not known, regression analysis often depends to some extent on making assumptions about the process.

Multiple Linear Regression Model

A regression model that contains more than one regressor variable is calleda multiple regression model. A multiple linear regression model is the Mathematics of stating the statistical relationship between one variable (dependent variable) and two or more other variables (independent variables). In this study the weight of an adult individual depends on the height, age and gender (Sex). A multiple regression model that might describe this relationship is $Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \varepsilon_i$ (2.1)

Where Y represents the weight, x_1 represents the height, $x_2$represents the age, $x_3$represents the gender (sex) and ε_i is a random error term. This is a multiple linear regression modelwith three regressors. The termlinearis used because Equation (2.1) is a linear function of the unknown parameters β_0, β_1, β_2, and β_3.

Where we have assumed that the expected value of the error term is zero; that is E (ε) =0.
The parameter$\beta_0$is the interceptof the plane,β_1, $\beta_2$and$\beta_3$partialregression coefficients,because β_1 measures the expected change in Y per unit change in x_1 when$x_2$and$x_3$are held constant, $\beta_2$measures the expected change in Y per unit change in x_2 when x_1 and $x_3$are held constant and $\beta_3$measures the expected change in Y per unit change in $x_3$when $x_1$and x_2 are held constant.

Least Square Estimation of the Parameters

The method of least squaresmay be used to estimate the regression coefficients in the Multiple

Regression model, Equation (2.1.) Suppose that n >kobservations are available, and let x_{ij}denote the ith observation or level of variable x_j.The observations are(x_{i1}, x_{i2},x_{ik}, y_i), i = 1, 2, ..., n and n>k. It is customary to present the data for multiple regression in a table such as Table 2.1.

Each observation (x_{i1}, x_{i2}...x_{ik}, y_i), satisfies the model in Equation (2.1)

$$Y_i = \beta_0 + \sum_{j=1}^{k} \beta_j x_{ij} + \varepsilon_i \qquad i = 1, 2, \ldots, n$$

The least square function is:$L = \sum_{i=1}^{n} \varepsilon_i^2 = \sum_{i=1}^{n} (y_i - \beta_0 - \sum_{j=1}^{k} \beta_j x_{ij})^2$By minimizing L with respect to β_0, β_1, ., β_k. The Least Square Estimate of β_0, β_1, . . , β_k are$\beta_0 = \bar{y} - \sum_{i=1}^{k} (\beta_i \bar{x}_i)$ $and \beta_k = \frac{SS_{xy}}{SS_{xx}}$.Where,
$SS_{xy} = n\sum_{i=1}^{n} x_{ki} y_i - (\sum_{i=1}^{n} x_{ki})(\sum_{i=1}^{n} y_i)andSS_{xx} = n\sum_{i=1}^{n} x_{ki}^2 - (\sum_{i=1}^{n} x_{ki})^2$.Where n is the number of observations from the normal population for β_0 and β_k and k is the number of the independent variables.

Underlying Assumptions

Classical assumptions for regression analysis include; the sample is a representative of the population for the inference prediction; the error is a random variable with a mean zero conditional on the explanatory variables; the independent variables are measured with no error. (Note: if this is not so, modeling may be done instead using error-in-variables model techniques); The predictors are linearly independent, i.e. it is not possible to express any predictor as a linear combination of the others; The errors are uncorrelated, that is, the variance-covariance matrix of the errors is diagonal and each non-zero element is the variance of the error; The variance of the error is constant across observations (homoscedasticity). (Note: if not, weighted least squares or other methods might instead be used).

Interpolation and Extrapolation

Regression model predicts a value of the Y variable given known values of the X variables. Prediction within the range of values in the dataset used for model-fitting is known informally as interpolation. Prediction outside this range of the data is known as extrapolation. Performing extrapolation relies strongly on the regression assumptions. The further the extrapolation goes outside the data, the more room there is for the model to fail due to differences between the assumptions and the sample data or the true values.

Lindley (1987) advised that when performing extrapolation, one should accompany the estimated value of the dependent variable with a prediction interval that represents the uncertainty. Such intervals tend to expand rapidly as the values of the independent variable(s) moved outside the range covered by the observed data.

Table 2.1: Analysis of variance (ANOVA) for testing significance of regression in multiple regression

Source of variation	Sum of squares	Degrees of freedom	Mean squares	F_0
Regression	SS_R	K	MS_R	MS_R/MS_E
Error	SS_E	n-p	MS_E	
Total	SS_T	n-1		

Source: Any Standard Statistics textbook.

Where, K is the degree of freedom, depending on the number of independent variable X $SST = n\sum_{i=1}^{n} y_i^2 - (\sum_{i=1}^{n} y_i)^2 = SS_{yy}$ and $SSR = \sum_{i=1}^{n} y_i^2 - \beta_0 \sum_{i=1}^{n} y_i - \beta_1 \sum_{i=1}^{n} x_1 y - \cdots \beta_k \sum_{i=1}^{n} x_k y$ i.e. $SSE = SST - SSR$

Data Analysis and Interpretation

Analysis of the data which as presented in Appendix I is made using SPSS software, coding the categorical data Male=0 and Female =1. Interpretations of the results of analysis were also performed.

Table 3.1: Classification of the subject based on BMI cut-offs

Underweight 18.4kg/m^2 or below	Normal weight 18.5kg/m^2–24.9kg/m^2	Overweight 25.0kg/m^2 – 29.9kg/m^2	Obese 30.0kg/m^2 or greater
4	88	51	17

Table 3.1 is a refinement of data in Appendix I; Percentage distribution of the body weight categories of the subjects based on BMI; 45% of the subjects are at abnormal weight that is (underweight 3%, overweight 32% and obese 10%), and normal weight 55%. Out of a total of the 160 subjects, 104 in early adulthood (18-39years), 38 in middle adulthood (40-59years) and 18 in advanced adulthood (60 and above).

Result and Analysis for the Regression between age, height, sex and weight

The relationship between the variables age, height, sex and weight was obtained using a Statistical Software (SPSS 20). The result of the analysis is shown in Table 3.2.

Table 3.2Coefficients of β_0, β_1, β_2, and β_3

		Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
	Model	B	Std. Error	Beta	t	Sig.	Lower Bound	Upper Bound
1	(Constant)	-.548	12.030		-.046	.964	-24.311	23.214
	Age	.213	.056	.288	3.813	.000	.103	.323
	Height	35.833	7.233	.366	4.954	.000	21.546	50.119
	Sex	-.913	1.613	-.042	-.566	.572	-4.100	2.273

a. Dependent Variable: Weight

From Table 3.2, the fitted regression model is

$$\hat{y} = -0.548 + 0.213(Age) + 35.833(Height) - 0.913(Sex) \quad (3.1)$$

Here y, is the dependent variable, which is the weight, while Age, Height and Sex are the independent or explanatory variables respectively.This implies that 0.213, 35.833and -0.913 are the average changes in y per unit change in Age, Height and Sex. Furthermore, Sex contributed negatively to the model.

Testing the Significance of the R**egression Parametersβ_0, β_1, β_2, and β_3**

From Table 3.2 the coefficients of the β_0, β_1, β_2, and $\beta_3$are –0.548. 0.213, 35.833 and -0.913 respectively, with Age and Height are significant and contributed positively to the model with height contributing the highest value of 35.833, while sex contributes negatively, thus not significant at 5% level of significant

Table 3.3: Model Summary for Regression between Age, Height, Sex and Weight

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.568[a]	.323	.310	8.849	.323	24.811	3	156	.000

a. Predictors: (Constant), Sex, Height, Age
b. Dependent Variable: Weight

From R is the correlation value (0.568), which implies that there exists an average positive relationship between the dependent variable (weight) and the independent variables (age height and sex). R^2 is 0.323this means that approximately 32% of the variability of weight is accounted for by the model for this data with significant F change.

Table 3.4: ANOVA for the regression parameters; age, height, sex and weight

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5828.815	3	1942.938	24.811	.000[a]
	Residual	12216.429	156	78.310		
	Total	18045.244	159			

a. Predictors: (Constant), Sex, Height, Age
b. Dependent Variable: Weight

From table 3.4, the P- value = 0.000is less than 5% level of significant; which means that our regression model is significant. Thus, we conclude that the model explains a statistically significant portion of the variability in the weight from the predictors: age, height and sex. Accept that at least one of the parameters is significant.

3.395% Confidence Interval for Regression Parameters

From table 3.2, the confidence intervals have been as; for β_0 is between (-24.311, 23.214); for β_1 is between (0.103 0.323); for β_2 is between (21.546 50.119); and for β_3 is between (-4.100 2.273).

The intercept β_0 (-0.568) falls within the interval (-24.311 23.214) at 95% C.I. The regression Parameter β_1 (0.213) falls within the interval (0.103 0.323) at 95% C.I. The regression

Parameter β_2 (35.833) falls within the interval (21.546 50.700) at 95% C.I. And also the regression Parameter β_3 (-0.913) falls within the interval (-4.100 2.273) at 95% C.I

Result and Analysis for the Regression of Weight on Age and Height

Table 3.5 Coefficients β_0, β_1, and β_2

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-3.135	11.104		-.282	.778	-25.068	18.797
	Age	.223	.053	.302	4.232	.000	.119	.327
	Height	36.840	6.995	.376	5.266	.000	23.023	50.657

a. Dependent Variable: Weight

From Table 3.5, the fitted regression model is $\hat{y} = -3.135 + 0.223(Age) + 36.84(Height)$(3.2)
Here y, is the dependent variable, which is the weight, while Age and Height are the independent or explanatory variables respectively. This implies that 0.223and 36.840 are the average changes in y per unit change in Age and Height.

Testing the Significance **of the Regression Parameters β_0, β_1, and β_2**
From Table 3.5; Both Age and Height are significant when Sex as a variable is step-down from the model for the dataset available for the study, although Height contributed much higher value of 36.840

Table 3.6: Model summaryfor the regression of weight on age and height

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.567[a]	.322	.313	8.830	.322	37.217	2	157	.000

a. Predictors: (Constant), Height, Age
R is the correlation value (0.567), which implies that there exists an average positive relationship between the dependent variable (weight) and the independent variables (Age and height). R^2 is 0.322 this means that approximately 32% of the weight is explained by the combination of Age and Height (m)

Table 3.7 ANOVA for the Regression Parameter Age, Height and Weight

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	5803.716	2	2901.858	37.217	.000[a]
	Residual	12241.528	157	77.972		
	Total	18045.244	159			

a. Predictors: (Constant), Height, Age
b. Dependent Variable: Weight

From table 3.7, the P- value = 0.000 is less than 5% level of significant; which means that our regression model is significant. Thus, we conclude that the model explains a statistically significant portion of the variability in the weight from the predictors: Age and Height. Accept that at least one of the parameters is significant.

Result and Analysis for the Regression of Weight on Age and Sex

Table 3.8: Coefficients β_0, β_1, and β_3

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	57.687	2.726		21.162	.000	52.303	63.071
	Age	.291	.057	.394	5.122	.000	.179	.404
	Sex	-2.955	1.661	-.137	-1.778	.077	-6.236	.327

a. Dependent Variable: Weight

From Table 3.8, the fitted regression model is: $\hat{y} = 57.687 + 0.291(Age) - 2.955(Sex)$ (3.3)Here y, is the dependent variable, which is the weight, while Age and Sex are the independent or explanatory variables respectively. This implies that 0.291 and -2.955 are the average changes in Y per unit change in Age and Sex.

Testing the Significance of the Regression Parameters β_0, β_1, and β_3

From Table 3.8; the value for Age is significant and contributed positively to the model, while Sex is not significant at 5% level and contributed negatively to the model based on the dataset for this study. This means that the model is not a good model for predicting weight.

Table 3.9: Model summaryfor the regression of weight on age and sex

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics			
					R Square Change	F Change	df1	df2	Sig. F Change
1	.466[a]	.218	.208	9.483	.218	21.825	2	157	.000

a. Predictors: (Constant), Sex, Age

b. Dependent Variable: Weight

R is the correlation value (0.466), which implies that there exists a very weak positive relationship between the dependent variable (weight) and the independent variables (Age and Sex). R^2 is 0.218 is low;this means that approximately 22% of the variability of weight is accounted for by the model.

Table 3.10: ANOVA for the regression of weight on age and sex

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3925.626	2	1962.813	21.825	.000[a]
	Residual	14119.617	157	89.934		
	Total	18045.244	159			

a. Predictors: (Constant), Sex, Age

b. Dependent Variable: Weight

From Table 3.10, the P- value = 0.000 is less than 5% level of significant; which means that our regression model is significant. Thus, we conclude that the model explains a statistically significant portion of the variability in the weight from the predictors: Age and Sex. Accept that at least one of the parameters is significant.

Result and Analysis for the Regression of Weight on Height and Sex

Table 3.11: Coefficients β_0, β_2, and β_3

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
		B	Std. Error	Beta			Lower Bound	Upper Bound
1	(Constant)	-4.761	12.455		-.382	.703	-29.363	19.840
	Sex	-2.866	1.590	-.133	-1.803	.073	-6.006	.274
	Height	43.688	7.219	.446	6.052	.000	29.430	57.947

a. Dependent Variable: Weight

From Table 3.11, the fitted regression model is: $\hat{y} = -4.761 + 43.688(Height) - 2.866(Sex)$ (3.4)

Here y, is the dependent variable, which is the weight, while Height and Sex are the independent or explanatory variables respectively. This implies that 43.688and -2.866 are the average changes in y per unit change in Height and Sex.

Testing the Significance of the Regression Parameters β_0, β_2, and β_3

From Table 3.1, the P-value= 0.000 is less than 5% level of significant for Height, this implies Height is significant while P-Value = 0.073 is greater than 5%, sex is not significant. This means that the model is not adequate for predicting weight.

Table 3.12: Model Summaryfor the Regression of Weight on Height and Sex

Model Summaryb

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.509[a]	.260	.250	9.225	.260	27.517	2	157	.000

a. Predictors: (Constant), Height, Sex

b. Dependent Variable: Weight

R is the correlation value (0.509), which implies that there exists aaverage positive relationship between the dependent variable (weight) and the independent variables (Height and Sex). R^2 is 0.260 this means that approximately 26% of the variability of weight is accounted for by the model. Implies is not a good model based on the dataset for estimating weight.

Table 3.13: ANOVA for the Regression Parameter Height, Sex and Weight

	Model	Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4683.640	2	2341.820	27.517	.000[a]
	Residual	13361.604	157	85.106		
	Total	18045.244	159			

a. Predictors: (Constant), Height, Sex
b. Dependent Variable: Weight

From Table 3.13, the P- value = 0.000 is less than 5% level of significant; which means that our regression model is significant. Thus, we conclude that the model explains a statistically significant portion of the variability in the weight from the predictors: Height and Sex. Accept that at least one of the parameters is significant.

Analysis of Goodness of fit test using Absolute Mean Deviation (MAD)

$MAD = \sum_{i=1}^{n} |\varepsilon_i| . \frac{1}{n} = \sum_{i=1}^{n} |y_i - \hat{y}| . \frac{1}{n}$ Where, n = 160 and

$\sum_{i=1}^{160} |\varepsilon_i| = 1301.657$ i.e. MAD =1301.657/160 = 8.135 ≈ 8kg

This means that the estimated weight of an individual with regards to his age, height and sex may deviate with an average of 8kg based on this study.

Discussion of Results

From the analysis of the results obtained in the section 3, it is evidence that the three variables that is age, height and sex are more significant in Table 3.4, Table 3.7, and 3.10. The various tests of significant show that regressing weight on age, height and sex gives the best fitted model on estimating weight. Regressing weight on age and height gives a better model than when weight is regress on sex and height or age and sex respectively. Sex and age alone could not estimate weight as the model fitted by regressing weight on age and sex could not predict better.

In conclusion, regressing weight on age, height and sex gives the best model in predicting weight of an adult individual with a mean deviation of 8kg based on this study.

Therefore, age, height and sex account for about 32% of human weight. Other factors such as exercise, eating habit, metabolic rate, constitute or make up the remaining 68% factors or variables that determine human weight (Harry Mills, 2005).

Finally, it is shown that an estimated weight of a person may deviate with an average weight of 8kg.

It is obvious that naturally weight, height and age are related, it thus provides an insight on how one can utilize his/her body. Regular visitation to a medical personnel's is hereby encouraged to monitor one's body since all the parameters are proportional to each other. The model obtained can serve as a watcher in other to be able to monitor your body weight to see if you are at abnormal or at normal weight, in accordance to the BMI cut-offs.

Overweight can be checked by increasing ones physical activity for at least 3 to5days per week. Food with high fat or sugar intake should be reduced and increase the intake of foods with low energy such as fruits and vegetables. Food with high fibres and water are recommended for

adults with overweight. Excessive weight gain of more than 5kg should be avoided by regular exercise, increase intake of vegetables and fruits and regular medical checkups to avoid or reduce the risk of chronic diseases.

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APPENDIX I

Dataon Age (Years), Height (m), Sex and Weight (Kg) of Respondents.

S/No.	Age	Height(m)	Sex	Weight(kg)
1	25	1.84	Female	65
2	27	1.86	Male	75
3	43	1.73	Female	68
4	49	1.79	Male	80
5	37	1.71	Male	55
6	44	1.98	Male	65
7	25	1.84	Female	75
8	48	1.87	Female	70
9	43	1.86	Male	65
10	41	1.67	Male	75
11	42	1.72	Male	80
12	39	1.73	Female	65
13	33	1.74	Female	68
14	35	1.75	Male	70
15	37	1.69	Male	80
16	16	1.32	Male	42
17	15	1.52	Female	41
18	14	1.62	Male	45
19	60	1.81	Male	80
20	40	1.79	Male	83
21	45	1.73	Female	75
22	18	1.53	Female	45
23	15	1.56	Male	49
24	40	1.80	Female	75
25	38	1.70	Female	75
26	36	1.67	Male	75

27	25	1.69	Male	55
28	27	1.68	Female	60
29	33	1.72	Male	75
30	40	1.73	Male	80
31	32	1.76	Female	78
32	27	1.67	Male	60
33	18	1.27	Female	45
34	19	1.33	Female	45
35	22	1.35	Male	50
36	36	1.67	Male	75
37	25	1.69	Male	55
38	27	1.68	Female	60
39	33	1.72	Male	75
40	33	1.77	Female	73
41	32	1.75	Female	55
42	26	1.73	Male	65
43	39	1.72	Male	70
44	30	1.67	Female	64
45	25	1.69	Male	65
46	29	1.78	Female	60
47	27	1.65	Female	60
48	24	1.63	Female	65
49	22	1.63	Male	75
50	23	1.61	Female	66
51	26	1.77	Male	69
52	27	1.87	Male	73
53	25	1.82	Male	65
54	27	1.73	Male	60
55	24	1.81	Male	65
56	22	1.65	Male	72
57	21	1.90	Male	86
58	53	1.72	Male	72
59	26	1.65	Male	75
60	23	1.75	Female	57
61	21	1.60	Female	49
62	22	1.67	Female	72
63	28	1.63	Female	64
64	34	1.64	Female	69
65	30	1.63	Female	52
66	36	1.55	Female	46
67	33	1.58	Female	83
68	21	1.74	Female	64
69	37	1.57	Female	65
70	24	1.55	Female	84
71	23	1.56	Female	63
72	24	1.51	Female	75
73	23	1.53	Female	79
74	29	1.57	Female	65

75	23	1.68	Female	67
76	26	1.57	Female	62
77	28	1.60	Female	77
78	20	1.60	Female	63
79	26	1.57	Female	50
80	25	1.58	Female	55
81	24	1.63	Female	55
82	25	1.60	Female	51
83	34	1.67	Female	85
84	22	1.60	Female	64
85	34	1.61	Female	82
86	28	1.70	Female	59
87	20	1.52	Female	50
88	33	1.63	Female	61
89	32	1.59	Female	50
90	29	1.66	Female	67
91	41	1.63	Female	53
92	25	1.62	Female	70
93	30	1.67	Female	63
94	28	1.64	Female	71
95	32	1.72	Female	55
96	29	1.61	Female	83
97	32	1.62	Female	48
98	32	1.53	Female	57
99	28	1.66	Female	66
100	35	1.68	Female	68
101	25	1.62	Female	62
102	32	1.56	Female	58
103	25	1.55	Female	63
104	26	1.51	Female	51
105	27	1.66	Female	58
106	19	1.71	Female	70
107	35	1.61	Female	67
108	28	1.62	Female	58
109	27	1.60	Female	51
110	31	1.69	Female	77
111	37	1.66	Female	75
112	21	1.72	Female	82
113	35	1.64	Female	72
114	40	1.74	Female	70
115	23	1.66	Female	72
116	26	1.50	Female	46
117	22	1.58	Female	52
118	29	1.55	Female	52
119	30	1.59	Female	60
120	45	1.75	Female	74
121	47	1.69	Female	80
122	60	1.75	Male	74

123	63	1.72	Male	68
124	58	1.69	Male	78
125	65	1.65	Male	75
126	69	1.67	Male	63
127	49	1.52	Male	55
128	67	1.73	Male	89
129	55	1.53	Female	68
130	51	1.78	Male	71
131	50	1.50	Female	56
132	58	1.72	Male	78
133	61	1.70	Female	66
134	67	1.77	Male	83
135	75	1.79	Male	80
136	54	1.60	Female	57
137	48	1.69	Male	75
138	46	1.74	Male	70
139	62	1.80	Female	69
140	71	1.65	Male	85
141	67	1.73	Male	82
142	49	1.66	Male	69
143	45	1.59	Male	72
144	35	1.60	Male	67
145	41	1.78	Male	65
146	59	1.62	Female	65
147	48	1.60	Male	74
148	64	1.75	Male	85
149	51	1.82	Male	71
150	57	1.85	Male	69
151	53	1.89	Male	61
152	68	1.79	Male	70
153	65	1.74	Male	68
154	49	1.77	Male	59
155	61	1.82	Male	73
156	66	1.68	Male	77
157	52	1.73	Male	78
158	49	1.70	Female	63
159	52	1.72	Female	74
160	62	1.74	Female	71

MODELING NIGERIAN ELECTRICITY GENERATION AND CONSUMPTION PATTERN

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Abstract
This study examined annual amount of electricity generated and consumed in Nigeria for the period spanning 1970 to 2012. The Box-Jenkins modeling approach was employed after the series were transformed to ensure stationarity using the first differencing method. The empirical results showed that ARIMA (1, 1, 0) and ARIMA (0, 1, 1) models fitted the electricity generation and consumption datasets adequately. The whiteness of the residuals from the models was verified using Ljung-Box methodology. Theprojections for both electricity generation and consumption for five years ahead were made with 80% and 95% confidence limits.

Keywords: Electricity generation, electricity consumption, Box-Jenkins modeling, Augmented Dickey-Fuller, Ljung-Box method, confidence limits

Introduction
Energy accessibility is one of the cardinal criteria to distinguish poor nations from the rich ones. This explains why the developed nations of the world generate more energy with steady power supply than developing and underdeveloped ones. Undoubtedly, adequate power supply is the bedrock for the socio-economic and technological development of any nation. Availability of power supply induces industrialization, good communication system, better healthcare delivery, improvedscience and technological advancement and general high standard of living of the citizens.

Nigeria, the most populous nation in Africa has 36 states and Federal Capital Territory (FCT). The nation is endowed with enormous energy resources (renewable and non-renewable) that could be used to generate power for her populace (Obadote, 2009). These resources include hydro, solar, wind, biomass, natural gas, coal, geothermal and so on. Unfortunately, to generate sufficient electricity to meet national demand has become herculean task for successive government in Nigeria till date.

Given the importance of the electricity to Nigeria economy, this paper utilizes statistical tools to model over 40 years of energy generation and consumption in Nigeria in order to project future values for both generation and consumption given the availability of endowed resources in Nigeria.

A Synopsis of Nigerian Energy Sector
Electricity was first produced in Nigeria in 1896. This was done using generators with 60kW capacity installed in Ijora, Lagos by the Colonial Government. The establishment of Nigeria Electricity Supply Company (NESCO) at Kurra falls (Plateau state), African Timber and Plywood (AT&P) Company at Sapele (Delta state) and Shell Development Company at Bonny (Rivers state) in 1925, 1930 and 1942 respectively, increased Nigerian electricity generation capacity within these periods. In 1946, Public Works Department (PWD) was established and charged

with the responsibility of supervising electricity generation and supply. About four years later, the Colonial Government on the recommendation of the Legislative Council (LC) set up Electricity Corporation of Nigeria (ECN) to coordinate and regulate all the activities of power generating plants in Nigeria which includes the operations of PWD.

To facilitate and enhance speedy completion of hydroelectric project in Kainji (Niger State), Niger Dams Authority (NDA) was established in 1962. The NDA was also given the mandate to develop hydropower potentials of the country and maintain dams and other projects on the River Niger. Meanwhile, the amalgamation of ECN and NDA became inevitable in 1972 which gave birth to the National Electric Power Authority (NEPA). The NEPA which was later rechristened Power Holding Company of Nigeria (PHCN) was given the monopoly to coordinate the generation, transmission, distribution, pricing and supply of electricity in Nigeria.

From the foregoing, it can be observed that between 1946 and 2005, the Nigeria power sector has transfigured from agency to agency which were totally controlled by the Federal Government. However, since March 2005, private organizations have been encouraged to actively participate in the Nigerian energy sector as evident in the Power Sector Reform Bill (PSRB) that was signed into law by the Administration of President OlusegunObasanjo (Obadote, 2009; Sambo et al., 2010).

Basically, Nigeria has three functional hydropower stations (Kainji, Jebba and Shiroro) with several other hydropower resources yet to be harnessed. The Kainji hydropower station on River Niger was commissioned in 1968 with an installed capacity of 320MW. The station was upgraded ten years later to the capacity of 760MW. The Jebba hydropower station is also on River Niger and is about 100km downstream of Kainji. It started operation in 1984 and has an installed capacity of 540MW. The Shiroro hydropower station was built on River Kaduna and commissioned in 1990 with a capacity to generate 600MW. Recently, the Nigerian Government approved counterpart funding for construction of three new hydropower stations, Zungeru, Mambilla and Gurara with 700MW, 350MW and 300MW capacities respectively.

Apart from hydropower stations, Nigeria has thermal generating stations in Sapele (commissioned in 1985 with 1,020MW installed capacity), Afam (1985 with 702 installed capacity), Egbin (1988 with 1,320 installed capacity), Delta (1993 with 840 installed capacity) among others. Despite all these, the nation's electricity demand is above the generation from the combined installed capacity of power stations in the country which results to epileptic supply of electricity. It is therefore imperative to study the generation and consumption of electricity in Nigeria so as to have a broader overview of the instability of power supply and its consumption over time. This would assist the government and other stakeholders to proffer strategies to ameliorate the situstion.

There are number of studies that had considered electricity generation, consumption and other indicators within the Nigeria context. See Ibitoye and Adenikinju (2007), Olusegun (2008), Akinlo (2009), Sambo et al. (2010), Esso (2010),Ubi et al. (2012),Akpan and Akpan (2012), Akinwale et al. (2013), Ogundipe and Apata (2013) among others. Specifically, Akpan and Akpan (2012) studied electricity consumption, carbon emissions and economic growth in Nigeria. They used annual data from 1970 to 2008 and employed a multivariate vector error correction approach to examine the causation between the pairs of electricity consumption, carbon emissions and economic growth. They reported that economic growth is associated with

increased carbon emissions which is induced by increase in the electricity consumption being generated mostly via burning of petroleum fuels by individual generating plant as a result of erratic power supply.

Other researchers have worked on electricity consumption and/or generation in developed and developing countries. See Chang et al. (2001), Yoo and Kim (2006), Mehrara (2007), Halicioghu (2009), Jamil and Ahmad (2010), Adebola (2011), Pao et al. (2011) among others. This present work modeled the Nigerian 43-year annual electricity generation and consumption and predicted future values for both generation and consumption.

Material and Methods

The datasets used for this study were extracted from Research Department of the Central Bank of Nigeria (CBN). Although, the statistics of energy generation, distribution and consumption were provided by the defunct National Electricity Power Authority (NEPA) which has the monopoly of the Nigerian energy information,the CBN, among other agencies, publishes such information as obtained from the PHCN on regular basis. There were two sets of data obtained for this study:the data on annual electricity generation and electricity consumption in Nigeria measured in megawatts per hour (MW/h) over forty-three years beginning from 1970 to 2012.

Time plots and autocorrelation function plots (ACF) were obtained for the datasets to examine the pattern of the series as shown by Figures 1 and 2 respectively. Augmented Dickey-Fuller (ADF) test was employed to confirm the non-stationarity displayed in the plots. Sequel to the not rejecting the null hypothesis of non-stationarity, first-difference approach was used to attain stationary in the data.

For the analysis, the Box-Jenkins' methodology was carried out on the data using ACF and PACF plots at different lags to identify appropriate models for the data on generation and consumption of electricity in Nigeria. Thereafter, the identified models were subjected to diagnostics and an information criterion was used to select an appropriate model for forecasting based on their corresponding estimates of the parameters. The analysis of data was done in the environment of R statistical package obtainable on www.cran.org. The results obtained from this analysis were presented and discussed in the next section.

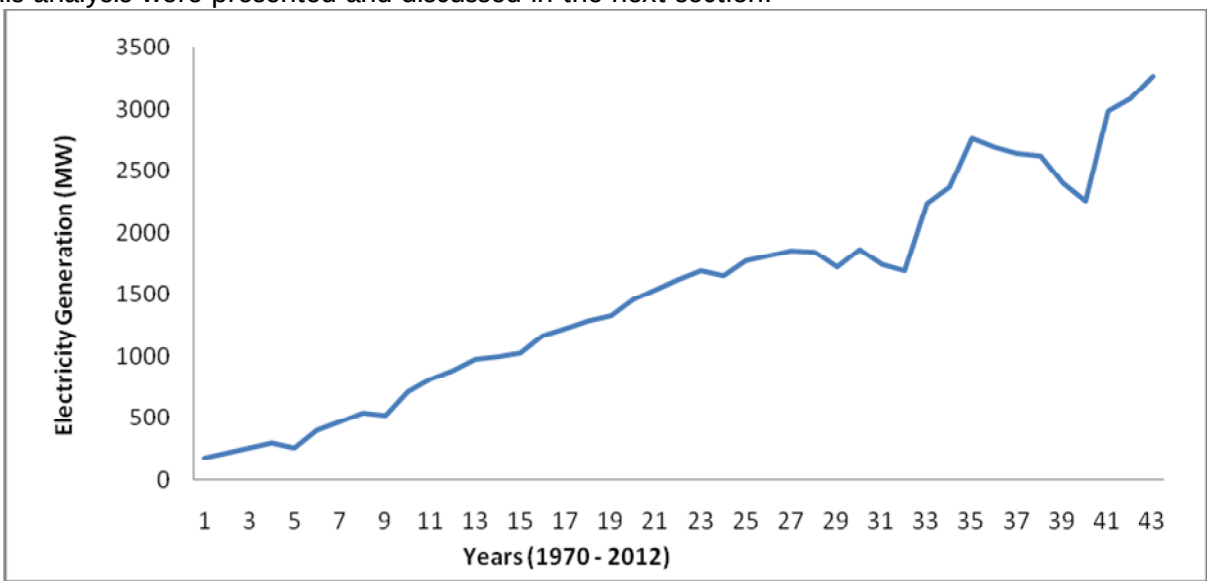

Figure 1: Time Plot for the Electricity Generation

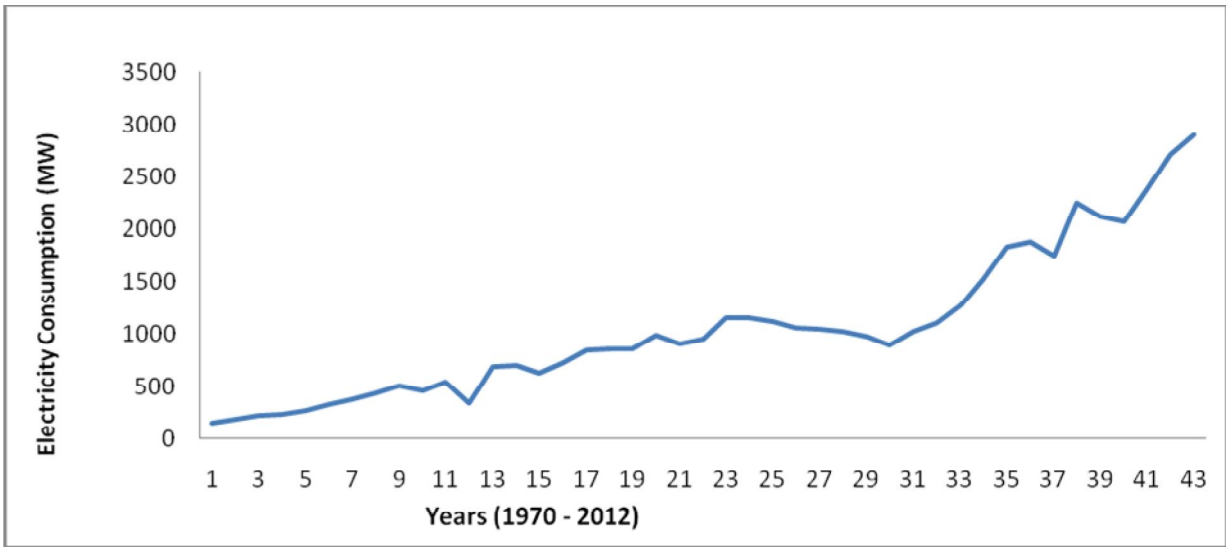

Figure 2: Time Plot for the Electricity Consumption

Thetime plots in Figures 1 and 2 show that the two series,the annual electricity generated and consumed in Nigeria between 1970 and 2012 are not stationary. Theydisplayed upward trends which were removed accordinglyafter the Augmented Dickey-Fuller test was performed to confirm the non-stationarity displayed by the time plots.

A formal procedure of testing for non-stationary or unit root was utilized and the findings are presented below.

Suppose the time series data on electricity generation and consumption are respectively denoted by X_t and Y_t. The electricity generated at time t is expected to be predicted by the electricity generated at immediate past time period (t-1). That is,

$$X_t = \rho X_{t-1} + \varepsilon_t \qquad (1)$$

Where

X_t *is electricity generated at time t,*

X_{t-1} *is the immediate pass value of* X_t, ρ *is the association between* X_t *and* X_{t-1}

, and ε_t *is the random error term at time t.*

Therefore, subtracting the lagged value of X_t from both sides of equation (1) yields

$$X_t - X_{t-1} = \rho X_{t-1} - X_{t-1} + \varepsilon_t \qquad (2)$$

$$X_t - X_{t-1} = (\rho - 1)X_{t-1} + \varepsilon_t$$

If we let $\alpha = \rho - 1$and $\Delta X_t = X_t - X_{t-1}$, then equation (2) becomes

$$\Delta X_t = \alpha X_{t-1} + \varepsilon_t \qquad (3)$$

If $\alpha = 0$, then $\rho = 1$ implying there is a unit root. This means the time series under consideration is non-stationary. But if $\alpha < 0$, then $\rho < 1$ indicates there is no unit root, which means the time series being considered is stationary.

The Augmented Dickey-Fuller test was used to test for the stationarity condition of the series. The test is equivalent to testing if α is significantly different from zero.The conventional t-test approach was adopted to test the significance of α value. The decision rule is to reject the null hypothesis if p-value is less than 5% level of significance.

Results and Discussion

Here, the results obtained from the analyses carried out are presented and discussed.
The test for stationarity of the two datasets showed that the data for electricity generation and consumption in Nigeria are not stationary (p-value = 0.1392 and 0.99 respectively).

Table 1: Results of Augmented Dickey-Fuller Tests

	Dickey-Fuller Statistic	Lag Order	P-value
Electricity Generation	-4.1255	3	0.1392
Electricity Consumption	0.1505	3	0.99

These results are in agreement with the deductions from the time plots in Figures 1 and 2. Hence, first-order differencing method was employed to attain stationarity in the two series.

The time plots for the differenced data are given in Figures 3 and 4. The series, Nigeria electricity generation and consumption, were found to be stationary after the first-difference transformation. Therefore, the series are technically referred to as time series of first order integration.

Figure 3: Time Plot for the Differenced Electricity Generation Data

Figure 4: Time Plot for the Differenced Electricity Generation Data

Based on the deductions from the correlograms and partial correlograms of the transformed data of the two series given as Figures 5 to 8 in the appendix, there is no evidence of visible signature that suggest the usage of AR, MA or ARMA model. Then the Box-Jenkins modeling approach also known as ARIMA model (Box and Jenkins, 1976) was adopted for this study. This approach is a four-step procedure involving identification, estimation, diagnosis and forecasting.

Model Identification

In accordance with inferences from the said correlogramsand the partial correlogramsof the transformed data in the appendix, the series exhibit random walk with drift. Let X_t^* and Y_t^* be the transformed data for electricity generation and electricity consumption respectively, the random work models with drift are

$$X_t^* = \alpha + X_{t-1}^* + \varepsilon_t^* \quad (4)$$

$$Y_t^* = \alpha + Y_{t-1}^* + \varepsilon_t^* \quad (5)$$

Model Estimation

The parameters of the models stated as equations 4 and 5 were estimated and the results were presented in Table 2.

Table 2: Estimates of ARIMA Model Parameters

Series	Parameter Estimate	Standard Error	t-value	P-values
X_t^*	73.6048	25.5058	2.8858	0.003904
Y_t^*	65.5520	22.349	2.9331	0.003356

Thus, the fitted models for Nigerian electricity generation and consumption were respectively

$$\widehat{X_t^*} = 73.6048 + X_{t-1}^* \quad (6)$$

and

$$\widehat{Y_t^*} = 65.5520 + Y_{t-1}^* \quad (7)$$

Model Diagnosis

Here, goodness-of-fit of the models to the datasets was verified, the conformity of white noise residuals of the fitted models was checked by plotting the ACFs and PACFs of the residuals emanated from the two models to observe whether they possess any pattern. It was discovered that the points on ACFs and PACFs plotted fall within the confidence limits at all lag points. Hence, the fitted models were adequate. The Ljung-Box test of no serial correlation was performed on the residuals of the fitted modelsvia the test statistic as

$$LB = n(n+2)\sum_{k=1}^{m}\left(\frac{\hat{\rho}_k^2}{n-k}\right) \sim \chi_m^2 \quad (8)$$

Table 2 presents the summarized results of the Ljung-Box statistical procedures performed on the two datasets.

Table 3: Results of the Ljung-Box test of no Serial Correlation of Residuals

Series	Statistic	df	P-value
X_t^*	17.2256	17	0.4392
Y_t^*	11.4787	17	0.8306

From Table 3, the LB statistics were 17.2256 and 11.4787 with the corresponding P-values of 0.4392 and 0.8306. These imply that the null hypothesis cannot be rejected, we therefore conclude that the residuals from the fitted models are not serially correlated thus they are white noise.

Forecasting

Having diagnosed the models and discovered that they were adequate and fit the data well, both electricity generation and consumption for the next five years (2013 – 2017) were predicted with 80% and 95% confidence limits. The projections in mega watts (MW) were given in Tables 4 and 5.

Table 4: Predicted Nigerian Electricity Generation (MW) for 2013 to 2017

Year	Predicted Electricity Generation	80% Confidence Limits		95% Confidence Limits	
		Lower	*Upper*	*Lower*	*Upper*
2013	3341.605	3129.769	3553.441	3017.63	3665.58
2014	3415.21	3115.628	3714.791	2957.039	3873.38
2015	3488.814	3121.904	3855.725	2927.673	4049.956
2016	3562.419	3138.747	3986.091	2914.469	4210.369
2017	3636.024	3162.344	4109.703	2911.593	4360.454

Table 5: Predicted Nigerian Electricity Consumption (MW) for 2013 to 2017

Year	Predicted Electricity Consumption	80% Confidence Limits		95% Confidence Limits	
		Lower	*Upper*	*Lower*	*Upper*
2013	2964.052	2778.433	3149.672	2680.171	3247.933
2014	3029.605	2767.099	3292.111	2628.136	3431.073
2015	3095.157	2773.654	3416.66	2603.461	3586.854
2016	3160.71	2789.47	3531.949	2592.947	3728.472

2017	3226.262	2811.203	3641.321	2591.485	3861.039

Conclusion

This paper examines the electricity generated and consumed in Nigeria between 1970 and 2012. The Box-Jenkins statistical modeling procedure was employed for this study. The Augmented Dickey-Fuller test carried out to examine the stationarity of the series showed that both series were not stationary. Hence, First-order differencing transformation was utilized to ensure stationarity. Our empirical results showed that the models fitted the data adequately and the Ljung-Box test performed confirmed the whiteness of the residuals from the models. We, therefore, made five years projections for both generation and consumption of electricity with both 80% and 95% confidence limits.

The predictions from the fitted models revealed that electricity generations shall be slightly improving in Nigeria starting from 2013, while the electricity consumption shall equally be increasing accordingly probably due to expansion in terms of population and amenities in Nigeria.

The amount of megawatts of electricity generation in Nigeria produced by the fitted model for 2013, 2014 and 2015 were quite close to the actual electricity generated by PHCN for 2013 and by the electricity generation companies (after unbinding) for 2014 and 2015.

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Appendix I

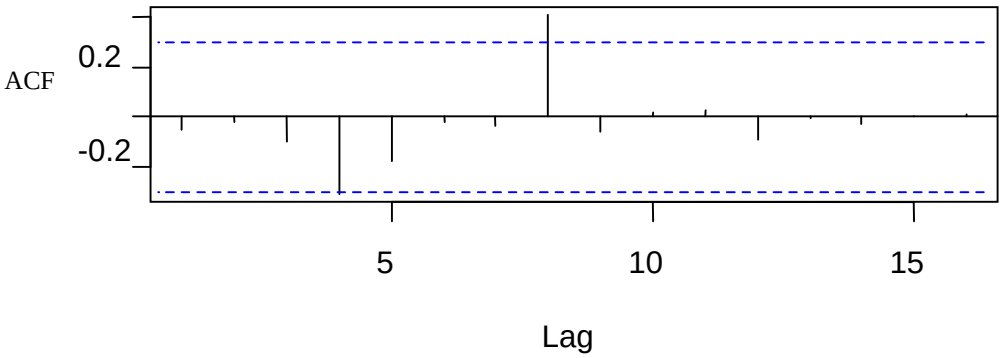

Figure 5: Plot of Autocorrelation for Differenced Electricity Generation

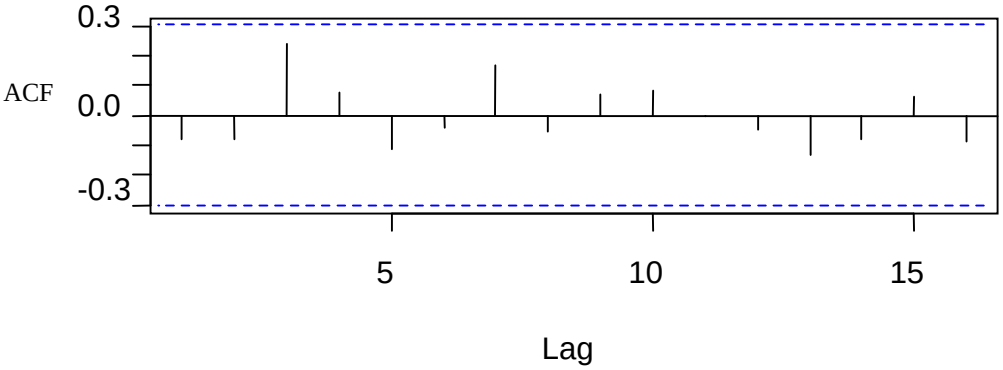

Figure 6: Plot of Autocorrelation for Differenced Electricity Consumption

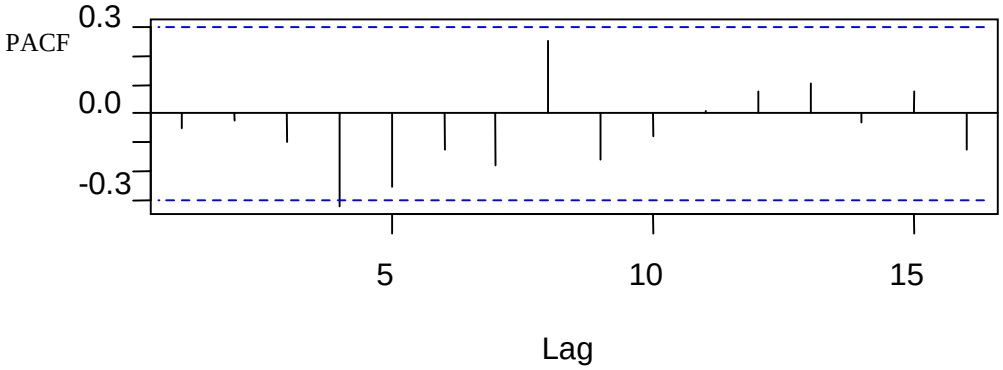

Figure 7: Plot of Partial Autocorrelation for Differenced Electricity Generation

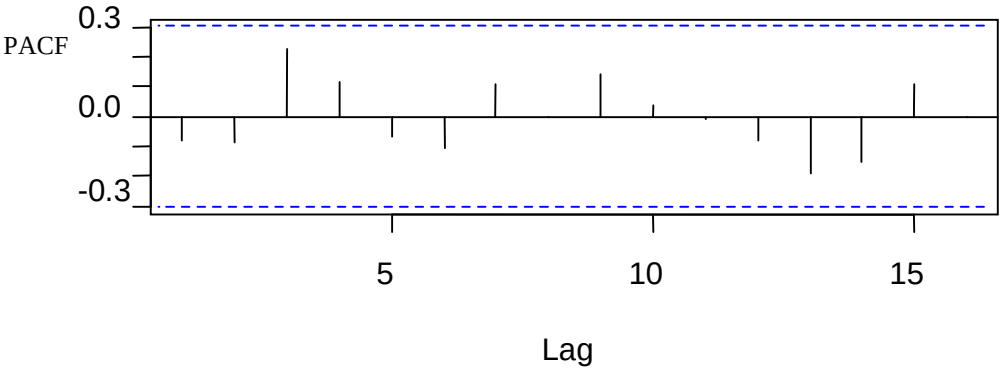

Figure 8: Plot of Partial Autocorrelation for Differenced Electricity Consumption

Appendix II

Nigerian Electricity Generation and Consumption in MW from 1970 to 2012

Year	Electricity Generation	Electricity Consumption	Year	Electricity Generation	Electricity Consumption
1970	176.6	145.3	1992	1693.4	1141.4
1971	215.4	181.1	1993	1655.8	1141.4
1972	255.4	211.1	1994	1772.9	1115
1973	299.7	232.7	1995	1810.1	1050.9
1974	261.1	266.2	1996	1854.2	1033.3
1975	395.4	318.7	1997	1839.8	1009.6
1976	468.7	369.8	1998	1724.9	972.8
1977	538	435.7	1999	1859.5	883.7
1978	522.7	504.4	2000	1738.3	1017.3
1979	710.7	460.1	2001	1689.9	1104.7
1980	815.1	536.9	2002	2237.3	1271.6
1981	887.7	335.9	2003	2367.5	1519.5
1982	973.9	685.6	2004	2763.6	1825.8
1983	994.6	696.7	2005	2687.3	1873.1
1984	1025.5	625.5	2006	2638.1	1742.9
1985	1166.8	717.4	2007	2623.1	2245.5
1986	1228.9	841.8	2008	2403.2	2108
1987	1286	852.9	2009	2257	2060.71
1988	1330.4	853.5	2010	2981.9	2383.08
1989	1462.7	976.8	2011	3086.1	2703
1990	1536.7	898.5	2012	3268	2898.5
1991	1617.2	946.6			

BLOCK IMPLICIT HYBRID LINEAR MULTISTEP METHODS FOR SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS

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Abstract
The idea of multistep collocation is employed to reformulate the Hybrid Backward Differentiation Formula (HBDF) for cases $k = 4$ and 6 into continuous forms which were evaluated at some interpolation and collocation points. This gives rise to discrete schemes that are combined to form the efficient block method for the solution of Ordinary Differential Equations. The requirement of starting values and the overlap of solution model which are associated with conventional Linear Multistep Methods are eliminated by this approach. A convergence analysis of the derived hybrid schemes is presented to establish their effectiveness and reliability. Numerical examples carried out further substantiates their convergence.

Keywords: Linear Multistep method (LMM), Backward Differentiation Formula (BDF), Block Solution, Implicit, Hybrid

Introduction
Consider the Initial Value Problem of the form

$$y' = f(x, y) \qquad y(x_0) = y_0 \qquad (1)$$

Where the solution y is assumed to be a differentiable function on an interval $[x_0, b], b < \infty$. Many methods for solving (1) exist, one particular method is the Linear Multistep Method. The Method require less evaluation of the derivative function f than one step methods in the range of integral $[x_0, b]$. For this reasons they have been very popular and important for solving (1) numerically. But these methods have certain limitations such as the overlap of solution models and the requirements of a starting value. Other limitations include they yield the discretely solution values $y_1, \dots, y_N$ hence uneconomical for producing dense output. A continuous formulation is desirable in this respect. The collocation method is probably the most important numerical procedure for the construction of continuous methods (Lie and Norsett, 1989; Awoyemi, Jator and sirisena, 1994; Onumanyi, sirisena and jator, 1999).

In this research paper, an attempt is made to reformulate the hybrid form of some BDF schemes, specifically $(k = 4 \; and \; 6)$ into continuous forms by the idea of multistep collocation.

The Continous Multistep Collocation (CMM) Method
Lambert (1973; 1991) adopted the continous finite difference (CFD) approximation approach by the idea of interpolation and collocation. Later, Lie and Norsett (1989), Onumanyi (1994; 1999) referred to it as Multistep Collocation (MC). The method is presented below

$$\underline{a} = (a_0, a_1, \dots\dots, a_{(t+m-1)})^T, \varphi(x) = (\varphi_0(x), \varphi_1(x), \dots\dots, \varphi_{(t+m-1)})^T \qquad (2)$$

where $a_r, r = 0, \dots\dots, t + m - 1$ are undetermined constants, $\varphi_r(x)$ are specified basis functions, T denotes transpose of, t denotes the number of interpolation points and m denotes the

number of distinct collocation points. We consider a continuous approximation (interpolant) Y(x) to y(x) in the form

$$y(x) = \sum_{r=0}^{t+m-1} a_r \varphi_r(x) = \underline{a}^T \varphi(x) \qquad (3)$$

which is valid in the sub-intervals $x_n \leq x \leq x_{n+k}$, where n = 0,k……,N – k. The quantities $x_0 = a, x_N = b, k, m, n, t$ $and\ \varphi_r(x), r = 0,1 \ldots, t+m-1$ are specified values. The constant co-efficient a_r of (3) can be determined using the conditions

$$y(x_{n+j}) = y_{n+j},\ j = 0,1, \ldots, t-1 \qquad (4)$$

$$y'(\overline{x}_j) = f_{n+j}\ \ j = 0,1, \ldots, m-1 \qquad (5)$$

Where

$$f_{n+j} = f(x_{n+j}, y_{n+j}) \qquad (6)$$

The distinct collocation points $x_0, \ldots\ldots\ldots\ldots x_{m-1}$, can be chosen freely from the set $[x_n, x_{n+k}]$. Equation (4),(5) and (6) are denoted by a single set of algebraic equations of the form

$$D\underline{a} = \underline{F} \qquad (7)$$

Where $\underline{F} = (y_n, y_{n+1} \ldots\ldots y_{n+t-1}, f_n, f_{n+1}, f_{n+m-1})^T$ (8)

$$\underline{a} = D^{-1}\underline{F} \qquad (9)$$

where $\underline{D}$ is the non-singular matrix of dimension $(t+m)$ below

$$\underline{D} = \begin{pmatrix} \varphi_0(x_n) & \cdots & \varphi_{t+m-1}(x_n) \\ \vdots & \vdots & \vdots \\ \varphi_0(x_{n+t-1}) & \cdots & \varphi_{t+m-1}(x_{n+t-1}) \\ \\ \varphi_0'(\overline{x}_0) & \cdots & \varphi_{t+m-1}'(\overline{x}_0) \\ \vdots & \vdots & \vdots \\ \varphi_0'(\overline{x}_{m-1}) & \cdots & \varphi_{t+m-1}'(\overline{x}_{m-1}) \end{pmatrix} \qquad (10)$$

By substituting (9) into (3), we obtain the MC formula

$$y(x) = F^T \underline{C}^T \varphi(x), \quad x_n \leq x \leq x_{n+k}\ \ n = 0, k, \ldots\ldots, N-k \qquad (11)$$

where

$\underline{C} \equiv \underline{D}^{-1} = (c_{ij}), i, j = 1, \ldots, t+m-1$

$$\underline{C} = \begin{pmatrix} c_{11} & \cdots & c_{1t} & c_{1,t+1} & \cdots & c_{1,t+m} \\ c_{21} & \cdots & c_{2t} & c_{2,t+1} & \cdots & c_{2,t+m} \\ \vdots & \vdots & \vdots & \vdots & \vdots & \vdots \\ c_{t+m1} & \cdots & c_{t+m,t} & c_{t+m,t+1} & \cdots & c_{t+m,t+m} \end{pmatrix}$$

with the numerical elements denoted by $c_{ij}, i, j = 1, \ldots, k+m$. By expanding $\underline{C}^T\varphi(x)$ in (11) yields the following

$$y(x) = (F)^T \begin{pmatrix} \sum_{r=0}^{t+m-1} C_{r+1,1}\varphi_r(x) \\ \vdots \\ \sum_{r=0}^{t+m-1} C_{r+1,k+m}\varphi_r(x) \end{pmatrix} \qquad (12)$$

$$y(x) = \sum_{j=0}^{t-1}\left(\sum_{r=0}^{t+m-1} C_{r+1,j+1}\varphi_r(x)\right. + \sum_{j=0}^{m-1} h\left(\sum_{r=0}^{k+m-1}\left(\frac{C_{r+1,j+1}}{h}\varphi_r(x)\right)\right) f_{n+j} \qquad (13)$$

$$y(x) = \sum_{j=0}^{t-1} \alpha_j(x) y_{n+j} + h\sum_{j=0}^{m-1} \beta_j(x) f_{n+j} \qquad (14)$$

where we construct $\alpha_j(x) and\ \beta_j(x)$ explicitly by

$$\alpha_j(x) = \sum_{r=0}^{t+m-1} C_{r+1,j+1}\varphi_r(x) \quad j = 0,1 \ldots\ldots t-1 \qquad (15)$$

$$\beta_j(x) = \sum_{r=0}^{k+m-1} \left(\frac{C_{r+1,j+1}}{h}\right. \varphi_r(x), j = 0,1 \ldots\ldots, m-1 \qquad (16)$$

a_r can be determined as follows:

$$y(x) = \left\{\sum_{r=0}^{t-1} \alpha_{j,r+1} y_{n+j} + h\sum_{j=0}^{m-1} \beta_{j,r+1} f_{n+j}\right\}\varphi_r(x) \qquad (17)$$

For $K = 4$, the general form of the method upon addition of one off grid point is expressed as;

$$\bar{y}(x) = \alpha_1(x)y_n + \alpha_2(x)y_{n+1} + \alpha_3(x)y_{n+2} + \alpha_4(x)y_{n+3} + \alpha_5(x)y_{n+\frac{1}{2}} + h\beta_0(x)f_{n+4}$$

(18)

The matrix D of the proposed method is expressed as:

$$\begin{bmatrix} 1 & x_n & x_n^2 & x_n^3 & x_n^4 & x_n^5 \\ 1 & x_n+h & (x_n+h)^2 & (x_n+h)^3 & (x_n+h)^4 & (x_n+h)^5 \\ 1 & x_n+2h & (x_n+2h)^2 & (x_n+2h)^3 & (x_n+2h)^4 & (x_n+2h)^5 \\ 1 & x_n+3h & (x_n+3h)^2 & (x_n+3h)^3 & (x_n+3h)^4 & (x_n+3h)^5 \\ 1 & x_n+\frac{1}{2}h & (x_n+\frac{1}{2}h)^2 & (x_n+\frac{1}{2}h)^3 & (x_n+\frac{1}{2}h)^4 & (x_n+\frac{1}{2}h)^5 \\ 0 & 1 & 2x_n+8h & 3(x_n+4h)^2 & 4(x_n+4h)^3 & 5(x_n+4h)^4 \end{bmatrix} \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \alpha_5 \\ \beta_0 \end{bmatrix} = \begin{bmatrix} y_n \\ y_{n+1} \\ y_{n+2} \\ y_{n+3} \\ y_{n+1/2} \\ f_{n+4} \end{bmatrix} \qquad (19)$$

i:e $Da = F$

The matrix D in equation (19) which when solved by matrix inversion technique or Gaussian Elimination method will yield the continuous coefficients substituted in (18) to obtain continous form of the four step block hybrid BDF with one off step interpolation point.

$$\Big(\frac{1}{2388}\frac{1}{h^5}(2388h^5+9688h^4+13191x_n^2h^3+7666x_n^3h^2+1953x_n^4h+178x_n^5)-$$
$$\frac{1}{1194}\frac{1}{h^5}(4844h^4+13191x_nh^3+11499x_n^2h^2+3906x_n^3h+445x_n^4)x+$$
$$\frac{1}{2388}\frac{13191h^3+22998x_nh^2+11718x_n^2h+1780x_n^3}{h^5}x^2-\frac{1}{1194}\frac{3833h^2+3906x_nh+890x_n^2}{h^5}x^3+\frac{1}{2388}\frac{1953h+890x_n}{h^5}x^4-$$
$$\frac{89}{1194h^5}x^5\Big)y_n+\Big(\frac{1}{398}\frac{1}{h^5}\big(x_n(1534h^4+4694x_nh^3+3785x_n^2h^2+1139x_n^3h+114x_n^4)\big)-$$
$$\frac{1}{398}\frac{1}{h^5}\big(x_n(1536h^4+4694x_nh^3+3785x_n^2h^2+1139x_n^3h+114x_n^4)\big)x+$$
$$\frac{1}{398}\frac{4694h^3+11355x_nh^2+6834x_n^2h+1140x_n^3}{h^5}x^2-\frac{1}{398}\frac{3785h^2+4556x_nh+1140x_n^2}{h^5}x^3+\frac{1}{398}\frac{1139h+570x_n}{h^5}x^4-$$
$$\frac{57}{199h^5}x^5\Big)y_{n+1}+\Big(-\frac{1}{2388}\frac{1}{h^5}\big(x_n(7591x_nh^3+7978x_n^2h^2+2837x_n^3h+314x_n^4+2136h^4)\big)+$$
$$\frac{1}{1194}\frac{1}{h^5}(7591x_nh^3+11967x_n^2h^2+5674x_n^3h+785x_n^4+1068h^4)x-$$
$$\frac{1}{2388}\frac{7591h^3+23934x_nh^2+17022x_n^2h+3140x_n^3}{h^5}x^2+\frac{1}{1194}\frac{3989h^2+5674x_nh+1570x_n^2}{h^5}x^3-$$
$$\frac{1}{2388}\frac{2837h+1570x_n}{h^5}x^4+\frac{157}{1194h^5}x^5\Big)y_{n+2}+\Big(\frac{1}{5970}\frac{1}{h^5}\big(x_n(4613x_n^2h^2+1893x_n^3h+230x_n^4+$$
$$4038x_nh^3+1088h^4)\big)-\frac{1}{5970}\frac{1}{h^5}(13839x_n^2h^2+7572x_n^3h+1150x_n^4+785x_n^4+8076x_nh^3+$$
$$1088h^4)x+\frac{1}{5970}\frac{13839x_nh^2+11358x_n^2h+2300x_n^3+4038h^3}{h^5}x^2-\frac{1}{5970}\frac{4613h^2+7572x_nh+2300x_n^2}{h^5}x^3+$$
$$\frac{1}{5970}\frac{1893h+1150x_n}{h^5}x^4+-\frac{23}{597h^5}x^5\Big)y_{n+3}+\Big(-\frac{32}{2985}\frac{1}{h^5}\big(x_n(25x_n^4+262x_n^3h+947x_n^2h^2+$$
$$1382x_nh^3+672h^4)\big)+\frac{32}{2985}\frac{1}{h^5}(125x_n^4+1048x_n^3h+2841x_n^2h^2+2764x_nh^3+672h^4)x-$$
$$\frac{32}{2985}\frac{250x_n^3+1572x_n^2h+2841x_nh^2+1382h^3}{h^5}x^2+\frac{32}{2985}\frac{250x_n^3+1048x_nh+947h^2}{h^5}x^3-\frac{32}{2985}\frac{125x_n+262h}{h^5}x^4+$$
$$\frac{160}{597h^5}x^5\Big)y_{n+1/2}+$$
$$\Big(-\frac{1}{398}\frac{x_n(2x_n^4+13x_n^3h+28x_n^2h^2+23x_nh^3+6h^4)}{h^4}+\frac{1}{199}\frac{5x_n^4+26x_n^3h+42x_n^2h^2+23x_nh^3+3h^4}{h^4}x-$$
$$\frac{1}{398}\frac{20x_n^3+78x_n^2h+84x_nh^2+23h^3}{h^4}x^2+\frac{2}{199}\frac{5x_n^2+13x_nh+7h^2}{h^4}x^3-\frac{1}{398}\frac{10x_n+13h}{h^4}x^4+\frac{1}{199h^4}x^5\Big)f_{n+4}\Big\} \qquad (20)$$

Evaluating (20) at points $x = x_{n+4}$ and its derivative at $x = x_{n+3}, x = x_{n+1}, , x = x_{n+2}, x = x_{n+1/2}$ yields the following five discrete hybrid schemes which are used as a block integrator;

$$-\frac{784}{199}y_{n+1}+\frac{588}{199}y_{n+2}-\frac{2352}{995}y_{n+3}+y_{n+4}+\frac{3072}{995}y_{n+1/2}=\frac{147}{199}y_n+\frac{84}{199}hf_{n+4}$$
$$-y_{n+1}-\frac{925}{2415}y_{n+2}+\frac{143}{2415}y_{n+3}+\frac{3712}{2415}y_{n+1/2}=\frac{515}{2415}y_n-\frac{1990}{2415}hf_{n+1}+\frac{10}{2415}hf_{n+4}$$
$$\frac{6390}{2305}y_{n+1}-y_{n+2}-\frac{942}{2305}y_{n+3}-\frac{3968}{2305}y_{n+1/2}=-\frac{825}{2305}y_n-\frac{2985}{2305}hf_{n+2}-\frac{45}{2305}hf_{n+4}$$
$$-\frac{19125}{9883}y_{n+1}+\frac{18075}{9883}y_{n+2}-y_{n+3}+\frac{14208}{9883}y_{n+1/2}=\frac{3275}{9883}y_n-\frac{5970}{9883}hf_{n+3}+\frac{450}{9883}hf_{n+4}$$
$$-\frac{204750}{125888}y_{n+1}+\frac{31675}{125888}y_{n+2}-\frac{5888}{125888}y_{n+3}+y_{n+1/2}=-\frac{53025}{125888}y_n-\frac{95520}{125888}hf_{n+1/2}-$$
$$\frac{450}{125888}hf_{n+4} \qquad (21)$$

Equation (21) constitute the members of a zero-stable block integrators of order $(5,5,5,5,5)^T$ with $C_6 = \left[-\frac{49}{995}, -\frac{227}{47760}, \frac{241}{23880}, -\frac{283}{9552}, \frac{1561}{305664}\right]^T$ as the error constants respectively. To start the integration

process with n=0, we use (21) and this produces $y_1, y_{1/2}, y_2, y_3$ and y_4 simultaneously without the need of any starting method (predictor).

For $K = 6$, the general form of the method upon addition of one off grid point is expressed as;

$$\bar{y}(x) = \alpha_1(x)y_n + \alpha_2(x)y_{n+1} + \alpha_3(x)y_{n+2} + \alpha_4(x)y_{n+3} + \alpha_5(x)y_{n+4} + \alpha_6(x)y_{n+5} + \alpha_7(x)y_{n+\frac{1}{2}} + h\beta_0(x)f_{n+6}$$

(22)

Recall from (7), $Da = F$

The matrix D of the proposed method is expressed as:

$$D = \begin{bmatrix} 1 & x_n & x_n^2 & x_n^3 & x_n^4 & x_n^5 & x_n^6 & x_n^7 \\ 1 & x_n+h & (x_n+h)^2 & (x_n+h)^3 & (x_n+h)^4 & (x_n+h)^5 & (x_n+h)^6 & (x_n+h)^7 \\ 1 & x_n+2h & (x_n+2h)^2 & (x_n+2h)^3 & (x_n+2h)^4 & (x_n+2h)^5 & (x_n+2h)^6 & (x_n+2h)^7 \\ 1 & x_n+3h & (x_n+3h)^2 & (x_n+3h)^3 & (x_n+3h)^4 & (x_n+3h)^5 & (x_n+3h)^6 & (x_n+3h)^7 \\ 1 & x_n+4h & (x_n+4h)^2 & (x_n+4h)^3 & (x_n+4h)^4 & (x_n+4h)^5 & (x_n+4h)^6 & (x_n+4h)^7 \\ 1 & x_n+5h & (x_n+5h)^2 & (x_n+5h)^3 & (x_n+5h)^4 & (x_n+5h)^5 & (x_n+5h)^6 & (x_n+5h)^7 \\ 1 & x_n+\frac{1}{2}h & (x_n+\frac{1}{2}h)^2 & (x_n+\frac{1}{2}h)^3 & (x_n+\frac{1}{2}h)^4 & (x_n+\frac{1}{2}h)^5 & \left(x_n+\frac{1}{2}h\right)^6 & \left(x_n+\frac{1}{2}h\right)^7 \\ 0 & 1 & 2x_n+12h & 3(x_n+6h)^2 & 4(x_n+6h)^3 & 5(x_n+6h)^4 & 6(x_n+6h)^5 & 7(x_n+6h)^6 \end{bmatrix} \quad (23)$$

The matrix D in equation (23) which when solved by matrix inversion technique or Gaussian Elimination method will yield the continuous coefficients substituted in (22) to obtain continous form of the six step block hybrid BDF with one off step interpolation point.

$$\bar{y}(x) = \frac{1}{h^7}\left(\frac{1}{1250640}Py_n + \frac{1}{13896}Qy_{n+1} + \frac{1}{20844}Ry_{n+2}\right) + \frac{1}{h^7}\left(\frac{1}{312660}Sy_{n+3} + \frac{1}{194544}Ty_{n+4} + \frac{1}{625320}Uy_{n+5}\right) + \frac{1}{h^7}\left(\frac{128}{547155}Vy_{n+1/2} + \frac{1}{20844}Wf_{n+6}\right) \quad (24)$$

where

$$P = (1250640h^7 + 3254x_n^7 + 71281x_n^6h + 624077x_n^5h^2 + 2798515x_n^4h^3 + 68333441x_n^3h^4 + 8892484x_n^2h^5 + 5552148x_nh^6) + (427686x_n^5h + 3120385x_n^4h^2 + 1194060x_n^3h^3 + 20500323x_n^2h^4 + 17784968x_nh^5 + 5552148h^6 + 22778x_n^6)x + (8892484h^5 + 1069215x_n^4h + 6240770x_n^3h^2 + 16791090x_n^2h^3 + 20500323x_nh^4 + 68334x_n^5)x^2 - (6833441h^4 + 11194060x_nh^3 + 6240770x_n^2h^2 + 1425620x_n^3h + 113890x_n^4)x^3 + 5(559703h^3 + 624077x_nh^2 + 213843x_n^2h + 22778x_n^3)x^4 - (624077h^2 + 427686x_nh + 68334x_n^2)x^5 + (10183h + 3254x_n)x^6 - (3254)x^7$$

$$Q = (4475x_n^6h + 36586x_n^5h^2 + 147569x_n^4h^3 + 302152x_n^3h^4 + 283124x_n^2h^5 + 82320x_nh^6 + 214x_n^7) - 2(13425x_n^5h + 91465x_n^4h^2 + 295138x_n^3h^3 + 453228x_n^2h^4 + 283124x_nh^5 + 41160h^6 + 749x_n^6)x + \left((283124h^5 + 67125x_n^4h + 365860x_n^3h^2 + 885414x_n^2h^3 + 906456x_nh^4 + 4494x_n^5)\right)x^2 - 2(151076h^4 + 295138x_nh^3 + 182930x_n^2h^2 + 44750x_n^3h + 3745x_n^4)x^3 + (147569h^3 + 182930x_nh^2 + 67125x_n^2h + 7490x_n^3)x^4 - 2(18293h^2 + 13425x_nh + 2247x_n^2)x^5 + (4475h + 1498x_n)x^6 - (214)x^7$$

$$R = -(5219x_n^6h + 39868x_n^5h^2 + 145934x_n^4h^3 + 259330x_n^3h^4 + 198767x_n^2h^5 + 50460x_nh^6 + 262x_n^7) + 2(15657x_n^5h + 99670x_n^4h^2 + 291868x_n^3h^3 + 388995x_n^2h^4 + 198767x_nh^5 + 25230h^6 + 917x_n^6)x - \left((198767h^5 + 78285x_n^4h + 398680x_n^3h^2 + 875604x_n^2h^3 + 777990x_nh^4 + 5502x_n^5)\right)x^2 + 2(129665h^4 + 291868x_nh^3 + 199340x_n^2h^2 + 52190x_n^3h + 4585x_n^4)x^3$$

$$+(145934h^3+199340x_nh^2+78285x_n^2h+9170x_n^3)x^4 \quad +2(19934h^2+15657x_nh+2751x_n^2)x^5$$
$$-(5219h+1834x_n)x^6+(262)x^7$$

$$S=(57449x_n^6h+410920x_n^5h^2+1384805x_n^4h^3+2240896x_n^3h^4+1603076x_n^2h^5+$$
$$390480x_nh^6+3034x_n^7)-2(172347x_n^5h+1027300x_n^4h^2+2769610x_n^3h^3+3361344x_n^2h^4+$$
$$1603076x_nh^5+195240h^6+10619x_n^6)x$$
$$+\Big((1603076h^5+861735x_n^4h+4109200x_n^3h^2+8308830x_n^2h^3+6722688x_nh^4+$$
$$63714x_n^5)\Big)x^2$$
$$-2(1120448h^4+2769610x_nh^3+2954600x_n^2h^2+574490x_n^3h+53095x_n^4)x^3$$
$$+5(276961h^3+410920x_nh^2+172347x_n^2h+21238x_n^3)x^4$$
$$-2(205460h^2+172347x_nh+31857x_n^2)x^5 \quad +7(8207h+3034x_n)x^6-(3034)x^7$$
$$T=-(16855x_n^6h+113399x_n^5h^2+358609x_n^4h^3+551291x_n^3h^4+381184x_n^2h^5+91020x_nh^6+$$
$$938x_n^7)+(101130x_n^5h+566995x_n^4h^2+1434436x_n^3h^3+1653873x_n^2h^4+762368x_nh^5+$$
$$91020h^6+6566x_n^6)x$$
$$-\Big((381184h^5+252825x_n^4h+1133990x_n^3h^2+2151654x_n^2h^3+1653873x_nh^4+19698x_n^5)\Big)x^2$$
$$+(551291h^4+1434436x_nh^3+1133990x_n^2h^2+337100x_n^3h+32830x_n^4)x^3$$
$$-(358609h^3+566995x_nh^2+252825x_n^2h+32830x_n^3)x^4$$
$$+(113399h^2+101130x_nh+19698x_n^2)x^5 \quad -(16855h+6566x_n)x^6+(938)x^7$$
$$U=(12287x_n^6h+78574x_n^5h^2+238385x_n^4h^3+355672x_n^3h^4+241268x_n^2h^5+56976x_nh^6+$$
$$718x_n^7)-2(36861x_n^5h+196435x_n^4h^2+476770x_n^3h^3+533508x_n^2h^4+241268x_nh^5+$$
$$28488h^6+2513x_n^6)x$$
$$+\Big((241268h^5+184305x_n^4h+785740x_n^3h^2+1430310x_n^2h^3+1067016x_nh^4+15078x_n^5)\Big)x^2$$
$$-2(177836h^4+476770x_nh^3+392870x_n^2h^2+122870x_n^3h+12565x_n^4)x^3$$
$$+5(47677h^3+78574x_nh^2+36861x_n^2h+5026x_n^3)x^4 \quad -2(39287h^2+36861x_nh+7539x_n^2)x^5$$
$$+(12287h+5026x_n)x^6-(718)x^7$$
$$V=-(1049x_n^6h+8875x_n^5h^2+37715x_n^4h^3+84076x_n^3h^4+91916x_n^2h^5+37680x_nh^6+$$
$$49x_n^7)+(6294x_n^5h+44375x_n^4h^2+150860x_n^3h^3+252228x_n^2h^4+183832x_nh^5+37680h^6+$$
$$343x_n^6)x$$
$$-\Big((91916h^5+15735x_n^4h+88750x_n^3h^2+226290x_n^2h^3+252228x_nh^4+1029x_n^5)\Big)x^2$$
$$+(84076h^4+150860x_nh^3+88750x_n^2h^2+20980x_n^3h+1715x_n^4)x^3$$
$$-(7543h^3+8875x_nh^2+3147x_n^2h+343x_n^3)x^4 \quad +(8875h^2+6294x_nh+1029x_n^2)x^5$$
$$-(1049h+343x_n)x^6+(49)x^7$$
$$W=-(31x_n^6h+185x_n^5h^2+535x_n^4h^3+773x_n^3h^4+514x_n^2h^5+120x_nh^6+2x_n^7)+(186x_n^5h+$$
$$925x_n^4h^2+2140x_n^3h^3+2319x_n^2h^4+1028x_nh^5+120h^6+14x_n^6)x$$
$$-\Big((514h^5+465x_n^4h+1850x_n^3h^2+3210x_n^2h^3+2319x_nh^4+42x_n^5)\Big)x^2$$
$$+(773h^4+2140x_nh^3+1850x_n^2h^2+620x_n^3h+70x_n^4)x^3$$
$$-5(107h^3+185x_nh^2+93x_n^2h+14x_n^3)x^4 \quad +(185h^2+186x_nh+42x_n^2)x^5$$
$$-(31h+14x_n)x^6+(2)x^7$$

Evaluating (24) at points $x=x_{n+6}$ and its derivative at $x=x_{n+5}, x=x_{n+4}, x=x_{n+3}, x=x_{n+2}, x=x_{n+1}, x=x_{n+1/2}$ yields the following seven discrete hybrid schemes which are used as block integrator;

$$-\frac{968}{193}y_{n+1}+\frac{3025}{579}y_{n+2}-\frac{9680}{1737}y_{n+3}+\frac{6050}{1351}y_{n+4}-\frac{4840}{1737}y_{n+5}+y_{n+6}+\frac{40960}{12159}y_{n+1/2}=\frac{1210}{1737}y_n-\frac{220}{579}hf_{n+6}$$

$$-y_{n+1}-\frac{119280}{106785}y_{n+2}+\frac{46172}{106785}y_{n+3}-\frac{15390}{106785}y_{n+4}+\frac{2821}{106785}y_{n+5}+\frac{217088}{106785}y_{n+1/2}=\frac{24626}{106785}y_n-\frac{145908}{106785}hf_{n+1}+\frac{168}{106785}hf_{n+6}$$

$$\frac{74340}{6510}y_{n+1}-y_{n+2}-\frac{47096}{6510}y_{n+3}+\frac{11790}{6510}y_{n+4}-\frac{1932}{6510}y_{n+5}-\frac{36864}{6510}y_{n+1/2}=-\frac{6272}{6510}y_n-\frac{60795}{6510}hf_{n+2}-\frac{105}{6510}hf_{n+6}$$

$$-\frac{574875}{322616}y_{n+1}+\frac{940800}{322616}y_{n+2}-y_{n+3}-\frac{366075}{322616}y_{n+4}+\frac{45395}{322616}y_{n+5}+\frac{342016}{322616}y_{n+\frac{1}{2}}=\frac{64645}{322616}y_n-\frac{729540}{322616}hf_{n+3}+\frac{2100}{322616}hf_{n+6}$$

$$\frac{768520}{703305}y_{n+1}-\frac{931980}{703305}y_{n+2}+\frac{1448048}{703305}y_{n+3}-y_{n+4}-\frac{183848}{703305}y_{n+5}-\frac{483328}{703305}y_{n+\frac{1}{2}}=-\frac{95893}{703305}y_n-\frac{729540}{703305}hf_{n+4}-\frac{5880}{703305}hf_{n+6}$$

$$-\frac{713475}{458521}y_{n+1}+\frac{781200}{458521}y_{n+2}-\frac{914340}{458521}y_{n+3}+\frac{930150}{458521}y_{n+4}-y_{n+5}+\frac{471040}{458521}y_{n+\frac{1}{2}}=\frac{96054}{458521}y_n-\frac{243180}{458521}hf_{n+5}+\frac{12600}{458521}hf_{n+6}$$

$$-\frac{83679750}{54281216}y_{n+1}+\frac{22799700}{54281216}y_{n+2}-\frac{10588116}{54281216}y_{n+3}+\frac{3779325}{54281216}y_{n+4}-\frac{716870}{54281216}y_{n+5}+y_{n+\frac{1}{2}}=-\frac{14124495}{54281216}y_n-\frac{81127040}{54281216}hf_{n+\frac{1}{2}}-\frac{44100}{54281216}hf_{n+6} \tag{25}$$

Equation (25) constitute the members of a zero-stable block integrators of order $(7,7,7,7,7,7,7)^T$ with $C_8=\left[-\frac{605}{16212},-\frac{1869}{8},\frac{951}{8},-\frac{29355}{16},\frac{14469}{4},-\frac{35955}{8},\frac{2143291}{32}\right]^T$ as the error constants respectively. To start the integration process with n=0, we use (25) and this produces $y_1, y_{1/2}, y_2, y_3, y_4, ,y_5$, and y_6 simultaneously without the need of any starting method (predictor).

Stability Analysis

Following Fatunla (1992;1994), that defined the block method to be zero-stable provided the roots $R_{ij}=1(1)k$ of the first characteristic polynomial $\rho(R)$ specified as

$$\rho(R)=\det\left|\sum_{i=0}^{k}A^{(i)}R^{k-i}\right|=0 \tag{26}$$

satisfies $|R_j|\leq 1$,the multiplicity must not exceed 2.

The block methods proposed in equations (21) for $k=4$ are put in the matrix equation form and for easy analysis the result was normalized to obtain

$$A^0=\begin{bmatrix}1&0&0&0&0\\0&1&0&0&0\\0&0&1&0&0\\0&0&0&1&0\\0&0&0&0&1\end{bmatrix},\quad A^1=\begin{bmatrix}0&0&0&0&1\\0&0&0&0&1\\0&0&0&0&1\\0&0&0&0&1\\0&0&0&0&1\end{bmatrix}$$

And

$$B^0=\begin{bmatrix}\frac{242}{225}&\frac{-4807}{5760}&\frac{2197}{5760}&\frac{-1427}{9600}&\frac{151}{5760}\\\frac{2008}{1575}&\frac{-179}{360}&\frac{119}{360}&\frac{-79}{600}&\frac{59}{2520}\\\frac{1856}{1575}&\frac{4}{45}&\frac{41}{45}&\frac{-16}{75}&\frac{11}{315}\\\frac{216}{175}&\frac{-3}{40}&\frac{63}{40}&\frac{51}{200}&\frac{3}{280}\\\frac{256}{225}&\frac{8}{45}&\frac{52}{45}&\frac{88}{75}&\frac{16}{45}\end{bmatrix},B^1=\begin{bmatrix}0&0&0&0&0\\0&0&0&0&0\\0&0&0&0&0\\0&0&0&0&0\\0&0&0&0&0\end{bmatrix}$$

The first characteristic polynomial of the block method is given by

$\rho(R) = \det(RA^0 - A^1)$ .Substituting the A^0 and A^1 into the function above gives

$$\rho(R) = \det\left[R\begin{bmatrix}1&0&0&0&0\\0&1&0&0&0\\0&0&1&0&0\\0&0&0&1&0\\0&0&0&0&1\end{bmatrix} - \begin{bmatrix}0&0&0&0&1\\0&0&0&0&1\\0&0&0&0&1\\0&0&0&0&1\\0&0&0&0&1\end{bmatrix}\right]$$

$$= det\left[\begin{bmatrix}R&0&0&0&0\\0&R&0&0&0\\0&0&R&0&0\\0&0&0&R&0\\0&0&0&0&R\end{bmatrix} - \begin{bmatrix}0&0&0&0&1\\0&0&0&0&1\\0&0&0&0&1\\0&0&0&0&1\\0&0&0&0&1\end{bmatrix}\right]$$

$$= det\begin{bmatrix}R&0&0&0&-1\\0&R&0&0&-1\\0&0&R&0&-1\\0&0&0&R&-1\\0&0&0&0&R-1\end{bmatrix}$$

$$= R^3(R(R-1)) - 0 = 0$$

$$R = 0\ (four\ times)\ or\ R = 1$$

The first characteristic polynomial of the block method is given by

$\rho(R) = \det(RA^0 - A^1)$ .Substituting the A^0 and A^1 into the function above gives

$$\rho(R) = \det\left[R\begin{bmatrix}1&0&0&0&0\\0&1&0&0&0\\0&0&1&0&0\\0&0&0&1&0\\0&0&0&0&1\end{bmatrix} - \begin{bmatrix}0&0&0&0&1\\0&0&0&0&1\\0&0&0&0&1\\0&0&0&0&1\\0&0&0&0&1\end{bmatrix}\right]$$

(27)

$$= det\left[\begin{bmatrix}R&0&0&0&0\\0&R&0&0&0\\0&0&R&0&0\\0&0&0&R&0\\0&0&0&0&R\end{bmatrix} - \begin{bmatrix}0&0&0&0&1\\0&0&0&0&1\\0&0&0&0&1\\0&0&0&0&1\\0&0&0&0&1\end{bmatrix}\right] = det\begin{bmatrix}R&0&0&0&-1\\0&R&0&0&-1\\0&0&R&0&-1\\0&0&0&R&-1\\0&0&0&0&R-1\end{bmatrix}$$

$$\Rightarrow R^3(R(R-1)) - 0 = 0$$

$$R_1 = R_2 = R_3 = R_4 = 0\ or\ R_5 = 1$$

From (3.0) and equation (27) the hybrid method is zero stable and consistent since the order of the method $p = 5 > 1$. And by Henrici (1962); the hybrid method is convergent.

Also, the block methods proposed in equations (25) for $k = 6$ are put in the matrix equation form and for easy analysis the result was normalized to obtain

$$
\begin{pmatrix}
\frac{40960}{12159} & -\frac{968}{195} & \frac{3025}{579} & \frac{-9680}{1737} & \frac{6050}{1551} & \frac{-4840}{1737} & 1 \\
\frac{217088}{106785} & -1 & \frac{-119280}{106785} & \frac{46172}{106785} & \frac{-15590}{106785} & \frac{2821}{106785} & 0 \\
\frac{-38864}{6510} & \frac{74340}{6510} & -1 & \frac{-47096}{6510} & \frac{11790}{6510} & \frac{-1932}{6510} & 0 \\
\frac{342016}{322616} & \frac{-574875}{322616} & \frac{940800}{322616} & -1 & \frac{-266076}{322616} & \frac{48595}{322616} & 0 \\
\frac{-483328}{703305} & \frac{758520}{703305} & \frac{-951980}{703305} & \frac{1448042}{703305} & -1 & \frac{-185842}{703305} & 0 \\
\frac{471040}{458521} & \frac{-715475}{458521} & \frac{751200}{458521} & \frac{-914340}{458521} & \frac{950150}{458521} & -1 & 0 \\
1 & \frac{-83679750}{54281216} & \frac{22799700}{54281216} & \frac{-10588116}{54281216} & \frac{3779525}{54281216} & \frac{-716870}{54281216} & 0
\end{pmatrix}
\begin{pmatrix} y_{n+\frac{1}{2}} \\ y_{n+1} \\ y_{n+2} \\ y_{n+3} \\ y_{n+4} \\ y_{n+5} \\ y_{n+6} \end{pmatrix} =
$$

$$
\begin{pmatrix}
0 & 0 & 0 & 0 & 0 & 0 & \frac{1210}{1737} \\
0 & 0 & 0 & 0 & 0 & 0 & \frac{24626}{106785} \\
0 & 0 & 0 & 0 & 0 & 0 & \frac{-6272}{6510} \\
0 & 0 & 0 & 0 & 0 & 0 & \frac{64645}{322616} \\
0 & 0 & 0 & 0 & 0 & 0 & \frac{-95895}{703305} \\
0 & 0 & 0 & 0 & 0 & 0 & \frac{96054}{458521} \\
0 & 0 & 0 & 0 & 0 & 0 & \frac{-14124495}{54281216}
\end{pmatrix}
\begin{pmatrix} y_{n-6} \\ y_{n-5} \\ y_{n-4} \\ y_{n-3} \\ y_{n-2} \\ y_{n-1} \\ y_n \end{pmatrix} +
$$

$$
h\begin{pmatrix}
0 & 0 & 0 & 0 & 0 & 0 & -\frac{220}{579} \\
0 & 0 & 0 & 0 & 0 & -\frac{145908}{106785} & \frac{168}{106785} \\
0 & 0 & \frac{-60795}{6510} & 0 & 0 & 0 & -\frac{105}{6510} \\
0 & 0 & 0 & -\frac{729540}{322616} & 0 & 0 & \frac{2100}{322616} \\
0 & 0 & 0 & 0 & -\frac{729540}{703305} & 0 & -\frac{5880}{703305} \\
0 & 0 & 0 & 0 & 0 & \frac{-243180}{458521} & \frac{12600}{458521} \\
\frac{-31127040}{54281216} & 0 & 0 & 0 & 0 & 0 & \frac{-44100}{54281216}
\end{pmatrix}
\begin{pmatrix} f_{n+\frac{1}{2}} \\ f_{n+1} \\ f_{n+2} \\ f_{n+3} \\ f_{n+4} \\ f_{n+5} \\ f_{n+6} \end{pmatrix} +
$$

$$
h\begin{pmatrix}
0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0
\end{pmatrix}
\begin{pmatrix} f_{n-6} \\ f_{n-5} \\ f_{n-4} \\ f_{n-3} \\ f_{n-2} \\ f_{n-1} \\ f_n \end{pmatrix}
$$

}..... (28)

The first characteristic polynomial of the block method is given by $\rho(R) = \det(RA^0 - A^1)$ .Substituting the A^0 and A^1 into the function above gives

$$
\rho(R) = \det\left[R\begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix} - \begin{bmatrix}
0 & 0 & 0 & 0 & 0 & 0 & 1 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 \\
0 & 0 & 0 & 0 & 0 & 0 & 1
\end{bmatrix}\right] \quad \text{.....(29)}
$$

$$= det\left[\begin{bmatrix} R & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & R & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & R & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & R & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & R & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & R & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & R \end{bmatrix} - \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}\right]$$

$$= det\begin{bmatrix} R & 0 & 0 & 0 & 0 & 0 & -1 \\ 0 & R & 0 & 0 & 0 & 0 & -1 \\ 0 & 0 & R & 0 & 0 & 0 & -1 \\ 0 & 0 & 0 & R & 0 & 0 & -1 \\ 0 & 0 & 0 & 0 & R & 0 & -1 \\ 0 & 0 & 0 & 0 & 0 & R & -1 \\ 0 & 0 & 0 & 0 & 0 & 0 & R-1 \end{bmatrix}$$

$= R^5(R(R-1)) - 0 = 0$

$\Longrightarrow R_1 = R_2 = R_3 = R_4 = R_5 = R_6 = 0 \ or \ R_7 = 1$

From (3.0) and equation (29) the hybrid method is zero stable and consistent since the order of the method $p = 7 > 1$. And by Henrici (1962); the hybrid method is convergent.

Numerical Example

To illustrate the performance of our proposed methods we will compare their performance with exact results. Consider the initial value problem

$y' = \lambda(y - x) + 1 \ , y(0) = 1$

The problem is stiff in nature for negative λ values and it has exact solution $y(x) = e^{\lambda x} + x$. This problem is considered for $\lambda = -5, and \ \lambda = -20$ with step length $h = 0.01$. The problem is solved using the Block Hybrid Backward Differentiation Formulae (BHBDF) for $k = 4$ and $k = 6$.

***Table* 1**: Proposed (BHBDF) for $k = 4, \lambda = -5$

N	X	Exact value	Approximate value	Error
0	0.00	1.000000000	1.000000000	0
1	0.01	0.961229424	0.961229424	$5.03E-10$
2	0.02	0.924837418	0.924837418	$3.9E-11$
3	0.03	0.890707976	0.890707976	$4.27E-10$
4	0.04	0.858730753	0.858730753	$8E-11$
5	0.05	0.828800783	0.828800783	$7.4E-11$
6	0.06	0.80081822	0.800818221	$3.17E-10$
7	0.07	0.774688089	0.77468809	$2.8E-10$
8	0.08	0.750320046	0.750320046	$3.7E-11$
9	0.09	0.727628151	0.727628152	$3.77E-10$
10	0.1	0.706530659	0.706530667	$2.86E-10$

***Table* 2**: Proposed (BHBDF) for $k = 4, \lambda = -20$

N	X	Exact value	Approximate value	Error
0	0.00	1.000000000	1.000000000	0
1	0.01	0.828730753	0.828769259	$3.8506896E-05$
2	0.02	0.690320046	0.690432454	$1.12408945E-04$
3	0.03	0.578811636	0.578993079	$1.81443769E-04$
4	0.04	0.489328964	0.489416887	$8.7923593E-04$

5	0.05	0.417879441	0.417989621	$1.10180194E-04$
6	0.06	0.361194211	0.361365196	$1.70985282E-04$
7	0.07	0.316596963	0.316826495	$2.29531969E-04$
8	0.08	0.281896518	0..282023466	$1.26948875E-04$
9	0.09	0.255298888	0. 255440879	$1.4199104E-04$
10	0.1	0.235335283	0.235532264	$1.96981522E-04$

Table 3: Proposed (BHBDF) for $k = 6, \lambda = -5$

N	X	Exact value	Approximate value	Error
0	0.00	1.000000000	1.000000000	0
1	0.01	0.961229424	0.961229424	0
2	0.02	0.924837418	0.924837418	0
3	0.03	0.890707976	0.890707976	0
4	0.04	0.858730753	0.858730753	0
5	0.05	0.828800783	0.828800783	0
6	0.06	0.80081822	0.80081822	0
7	0.07	0.774688089	0.774688089	0
8	0.08	0.750320046	0.750320046	0
9	0.09	0.727628151	0.727628151	0
10	0.1	0.706530659	0.706530659	0

Table 4: Proposed (BHBDF) for $k = 6, \lambda = -20$

N	X	Exact value	Approximate value	Error
0	0.00	1.000000000	1.000000000	0
1	0.01	0.828730753	0.828730765	$1.2E-08$
2	0.02	0.690320046	0.690320059	$1.3\ E-08$
3	0.03	0.578811636	0.578811645	$9.0E-09$
4	0.04	0.489328964	0.489328973	$9.0E-09$
5	0.05	0.417879441	0.417879445	$4.-09$
6	0.06	0.361194211	0.361194228	$1.7E-08$
7	0.07	0.316596963	0.316596981	$1E-08$
8	0.08	0.281896518	0..281896533	$1.5\ E-08$
9	0.09	0.255298888	0. 2552989	$1.2E-08$
10	0.1	0.235335283	0.235335293	$1.0E-08$

It would be observed from the results in tables 1 and 2 that the error alternates, that's for BHBDF 4 for $\lambda = -5$ and $\lambda = -20$ respectively. The BHBDF6 with $\lambda = -5$ is the best in terms of performance and accuracy as indicated in table 3.In table 4, the BHBDF6 with $\lambda = -20$ shows an alternate in error, but is of higher accuracy in comparison with results in table 2. However all the block methods produce accurate results when compared with exact results.

Conclusions

We have derived the hybrid form of the Backward Differentiation Formulae (BDF) for $k = 4$ and $k = 6$. The idea of Multistep Collocation (MC) was used to reformulate the derived hybrid formulae into continous form which were employed as block methods for direct solution of $y' = f(x, y)$. A convergence analysis of the discrete hybrid methods to establish their

effectiveness and reliability is presented. The methods were tested on some stiff IVP and shown to perform satisfactorily without the requirement of any starting method.

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ARTICLES AND RESEARCH REPORTS ON EDUCATION

IMPACT OF FIELD-BASED INQUIRY METHOD OF INSTRUCTION ON SCIENCE ACHIEVEMENT OF PRIMARY PUPILS OF PRIVATE SCHOOLS IN MAKURDI

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Abstract
Inspite of the recommendations of curriculum planners for teachers to use guided inquiry approach in teaching primary pupils, emphasis is still on conventional instructional strategy; though it is rich in content delivery, it does not engage students in active, authentic and scientific investigation. This study therefore determined the extent to which the field-based, inquiry method of instruction (FBIMI) will be effective in impacting primary school pupils' science achievement as compared to the conventional strategy. The study adopted a quasi-experimental design particularly a non-equivalent control pre-test and post-test group type. The sample for the study consisted of 329 pupils from six schools selected through both purposive and random sampling techniques. Basic Science and Technology Achievement Test (BSTAT) made up of 25 multiple choice items (of options A to E) was the instrument used in this study. The reliability estimate for BSTAT was found to be 0.87. It was found that teaching method, FBIMI is an important factor in science achievement of learners and the students exposed to FBIMI achieved significantly higher than those exposed to conventional strategy. The study revealed no gender disparity in science achievement with the use of FBIMI at primary school level. FBIMI is very suitable for pupils of primary school age therefore; Basic Science and Technology Curriculum by NERDC should include the use of outdoor, field-based experiences among its teaching and learning materials. Also, school supervisors should ensure that teachers use FBIMI as teaching strategy for basic science and technology.

Keywords: Inquiry method; Field-based inquiry strategy; pupils' science achievement; basic science

Introduction
Discoveries in psychology and brain neurophysiology led to new and renewed theories of learning which advocate knowledge construction rather than knowledge transmission. Inquiry-based curriculum and teaching techniques emerged as a combination of several such theories such as Lev Vygosky's constructivism theory, Bloom's taxonomy of learning, Piaget's theory of intellectual development, Howard Gardner's theory of multiple intelligences, Georgi Lazanov's theory of accelerated learning also called brain-based or whole brain learning. The origin of the modern day concept of science teaching as inquiry lies with the 1960s National Science Foundation (NSF) funded curriculum projects (DeBeor, 1991; Rudolph, 2002; Anderson, 2003). From the onset of the introduction of science into schools it was advocated that science instruction be based on sense perceptions and experience with the physical world, the gathering of data, rational argument and the drawing of conclusions based on available data.

The process of inquiry is aimed at enhancing learning by increasing learner involvement, multiple ways of knowing and sequential phases of cognition. Inquiry-based curriculum has been shown to develop independent and critical thinking skills, positive attitudes and curiosity

toward science and increased achievement (Johnstone & Al-Shuaili, 2001; Schneider, Krajcik, Marx & Soloway, 2002; Beerer, 2004; Wenning, 2005, Millar, 2009). Despite its advantages, few people practise inquiry-based education. As it is the case with any new pedagogy, there are a lot of forces opposing the practice of inquiry. For example, Abel and Roth (1992) and Beerer (2004) enumerated some of the factors influencing science teaching in primary school as insufficient instruction time in comparison to other subjects, teacher perception of the importance of science in an elementary curriculum, limited content knowledge held by elementary teachers, limited experience through formal course work in participating in and presenting hands-on science and lack of administrative support for the teaching of science. But Thiers (2000) argued that there are important economic, environmental and social realities that demand new skills and literacy from our students today. Igboko and Ibeneme (2006) identified globalization and rapid technological changes as some of the contributory factors to the shift from traditional educational practices such as programmed instruction, demonstration method and lecture or expository methods which have proved incapable of producing the effects required for coping with the challenges posed by globalization and rapid technological development. They further advocated that the realities of globalization earnestly calls for turning out skilled workers who are flexible, adaptable and imbued with higher-order thinking, problem-solving and collaborative work skills. Polman (2000) cited the Secretary's Commission on Achieving Necessary Skills (SCANS) as saying that the information-oriented and service-oriented sectors of the economy require more active problem-solvers, rather than passive direction followers, and that inquiry based curricula and pedagogy are out to address this need.

In Nigeria, Olanrewaju (1999) and Martins (1994) identified a mode of teaching in schools whereby teachers are initiators of learning and pupils are passive listeners. Albert (2000) observed that this method is rather a familiar feature of science classes in which teachers provide students with a large set of science facts along with the many special science words that are needed to describe them. According to Albert such teacher seems to be preparing students for a quiz competition rather than preparing them for life and so his teaching may not capture the interest of students who are making preparation to cope with life.

In America the National Research Council (NRC) and American Association for Advancement in Science (AAAS) have developed a programme of science teaching by inquiry across the K – 12 grades (NRC, 2000, 2001). As a matter of fact the inquiry pedagogy has been adopted by the entire American Science Community as well as the National Science Teachers Association (NSTA), the National Association for Research in Science Teaching (NARST) and the Association for Educators of Teachers of Science (AETS). Beerer (2004) opined that life-long literacy is not just knowing how to read and write but to acquire the ability to understand and use science. Literacy in science and ability to use science has actually placed some nations of the world as advanced and others as third world countries. According to the National Science Education Standards (NSES), to develop a scientific individual entails providing classroom learners with a science curriculum that teaches science as a body of knowledge and as a way of knowing about the natural world based on evidence from observation and experimentation (NRC, 1996)
Inquiry is central to science teaching and learning. When engaged in inquiry, students describe objects and events, ask questions, construct explanations, test those explanations against current or prevalent scientific knowledge and communicate their ideas to others (NRC, 1996; Beerer, 2004). Beerer concurs with the idea that inquiry approach is multifaceted and he outlined its benefits which include fostering curiosity as a habit of the mind and providing teaching strategies for motivating learning. Albert (2000) added that knowledge gained by

inquiry approach is more likely to be retained and incorporated permanently into the students' view of the world than knowledge gained otherwise.

The emphasis on inquiry based approach to teaching is not found in reports, standards and reform movements in America alone. In Africa and Nigeria in particular, frantic efforts have been made towards this direction of teaching and learning science. The African Primary Science Project (APSP) later called Science Education Programme for Africa (SEPA) and the Nigerian Integrated Science Project (NISP) are good examples of efforts towards inquiry based instruction. Topmost on the list of the aims of APSP is to develop children with first hand familiarity with a variety of biological, physical and man-made phenomena in the world around them. Secondly, to develop children in further exploration of the world around them based on their own initiative. Thirdly, to develop in children the ability to find out things for themselves, to see problems and be able to set about resolving them. On the basis of these aims the curriculum was focused on the study of concrete phenomena.

In Nigeria, Martins (1994) affirms that in the inquiry approach, memorization of isolated facts is discouraged. Instead, students are encouraged to 'learn how to learn'. She further highlighted the teaching methods recommended in Science Teachers Association of Nigeria (STAN) newsletter no. 1 (1970) as follows:

(i) use of discovery teaching tactics;
(ii) inclusion of problem solving activities;
(iii) involvement of students in open ended laboratory exercises.

As a matter of fact, all the methods recommended are inquiry based. Despite the overwhelming acceptance of inquiry focused learning based on concrete, biological, physical and man-made phenomena, research reports on how to teach using such a method are not common. Presently the philosophy of science education has slightly changed to emphasize technology education as early as primary school level so that learners acquire the skills they need for life and work. Achor (2003) observed that besides making the technology aspect of the curriculum so outstanding early in a child's education, basic science and technology requires that learning be made practical to depict its inquiry oriented nature and so make it easier to understand.

Direct field experiences with opportunities for active, authentic scientific investigation offers promise of helping pre-service teachers develop the needed skills for inquiry-based teaching (Nugent, Kunz, Levy, Harwood & Carlson, 2008). It is hoped that this approach will also be useful in helping primary school pupils' to improve their science achievement, retention of science knowledge and acquisition of science process skills. The problem of science teaching in Nigeria is not so much the issue of poor curriculum as it is of poor implementation. Moreover, in primary schools, implementing a standard based curriculum is a formidable challenge to primary school teachers most of whom are not specialists.

The science community worldwide has accepted the superiority of the inquiry approach to teaching and learning science over other methods. However, research on the impact or effectiveness of field-based inquiry method of instruction on primary school pupils' learning of science is scarce, especially at the lower basic level in Benue State and Nigeria. The State is noted to witness poor achievement of students in science at the secondary school level (Ogbeba, 2009; Shikkan, 2006) and therefore researchers have began to question what happens in terms of achievement at the primary school level. Etuk, Etuk, Etukudor-Eyo and

Samuel (2011) noted the poor performance of pupils in science at the primary school level in Nigeria. The authors also found that constructivist instructional strategy facilitated pupils' achievement in science more than expository instructional strategy.

This researcher is interested in finding out the impact of a field-based inquiry method of instruction on basic science and technology achievement. Thus, this research assessed the influence of field activities, as compared to classroom-contained activities on primary school pupils' science achievement. Rickinson, Dillon, Teamey, Morris, Choi, Sanders and Benefield (2004) concluded that well planned and delivered field work provides experiences that cannot be duplicated in the classroom; it positively impacts learning leading to reinforcement between affective and cognitive domains of learning and higher level learning.

Pupils in primary school are said to achieve in science when they are able to group similar materials and relate their basic properties to everyday uses. They should be able to describe the growth of plants and explain the life-cycles of familiar animals; give examples of forces, including the behaviour of magnets. From simple practical investigations, they should be able to observe main features and changes, and recording their findings as a picture or display; name and describe planets of the solar system, outline the water cycle, and sort animals into main groups. They need to know more about specific forces such as friction and gravity, and build, explain simple electrical circuits, explain a wider range of scientific ideas, such as how water could be purified, or how plants reproduced and benefited the environment by producing oxygen. They are expected to demonstrate understanding of the basic properties of electricity, light and sound, and how different forms of energy could be inter-converted (Martin, Mulis, Beaton, Gonzalez, Smith, & Kelly, 1997).

The question as to whether there are gender differences in mathematics and science achievement remains unanswered. While some findings indicate that there are differences, it is unclear whether such differences are actually gender or age – specific or they are due to differences in attitudes or opportunities for mathematics and science (Ogbeba, 2009; Etuk, Etuk, Etukudor-Eyo & Samuel, 2011). Specifically, there were no gender differences in problem solving in elementary or middle school, but differences favouring males emerged in high school and in college (Manning, 1998; Lee, 2002). This researcher is interested in finding out what obtains in primary school class five in (lower basic five) in Makurdi, Benue state.

Statement of the Problem

Over the last four decades, a lot of efforts have been made towards curriculum improvement, in the area of teaching methods and the achievement of Nigerian students in the sciences. Other efforts at promoting science learning and the choice of science courses in colleges and universities included the 60:40 admission policy in tertiary institutions in favour of science courses, scholarship allowances paid to science students and science allowances paid to science teachers and so on. These efforts have not really yielded the expected outcome, neither have science students filled the 60% quota given them. No nation of the world became technologically developed by simply exposing her citizens to the facts, principles and theories of science. Rather, it is the involvement of learners in active hands-on activities through inquiry pedagogy that could lead to technologically developed minds which are capable of causing technological development.

In Nigeria, studies by Mani (1981), Olanrewaju (1999), Tarjudeen (2001) and Shikaan (2006) showed that inspite of the recommendations of curriculum planners for teachers to use guided inquiry approach in teaching, this is not done. The traditional expository approach to teaching, though rich in content delivery, does not engage students in active, authentic, scientific investigation, nor does it adequately address the problem solving process and inquiry skills students need to acquire to cope with today's world.

This study therefore determined the extent to which the field-based, inquiry method of instruction will be effective in impacting primary school pupils' science achievement as compared to the conventional strategy.

Purpose of the Study

The purpose of this study was to determine the impact of field-based inquiry method of instruction on primary school pupils' science achievement. The study set out to achieve the following specific objectives:

(i) Determine the difference if any in the achievement of pupils taught science using field-based inquiry method of instruction and the achievement of those taught science by conventional strategy.

(ii) Compare the achievement of boys and girls taught using the field-based inquiry method of instruction.

Research Questions

The study aimed at finding answers to the following questions:

(i) What is the difference in science achievement between pupils taught science using field-based inquiry method and those taught using conventional strategy?

(ii) How do girls compare with boys in mean science achievement when exposed to the field-based inquiry method of instruction?

Research Hypotheses

The following null hypotheses (Ho) were tested at 0.05 alpha level of significance:

Ho_1 There is no significant difference between the mean achievement scores of pupils taught science using field-based, inquiry method of instruction and those taught with conventional strategy.

Ho_2 The mean achievement scores of boys and girls do not differ significantly when they are taught using the FBIMI.

Research Method

The study adopted a quasi-experimental design, investigating cause - effect relationship. The type of quasi-experimental design adopted was the non-equivalent control group design. This is because intact classes existing in the primary schools were used in order not to disrupt school operations. Specifically the result of the experimental group which was taught using the field-based inquiry method was compared with the control group, which was taught using the lecture method. Quasi-experimental design approximates the conditions of true experiments in a setting which does not allow control and manipulation of variables. Sambo (2008) is of the view that it is natural to use existing classrooms in schools for a study and a lot simpler than to start creating classroom groups through random selection and random assignment. He further comments that the non-equivalent control group design is worth using when the true experimental designs are not possible.

The study population consists of all primary five (5th graders) pupils of the 118 government approved private primary schools in Makurdi, Benue state. Available data in the Ministry of Education statistic department, Makurdi area dated April, 2011 showed that there were 10,620 primary five pupils. Primary five pupils are particularly chosen because they are expected to have covered a significant amount of what should be taught in primary school in basic science and technology curriculum. The choice is also to check the interference of pupils' literacy level and the comprehension of concepts taught since at this level, most pupils can read and write.

The sample for the study consisted of three hundred and twenty-nine pupils (329) from six schools selected by random sampling. Ali (2006) said that smaller samples are preferred for experimental studies in order not to make the study unwieldy or intractable since experimental studies impose more rigorous demands on the researcher. The sample size was selected in consideration of the fact that the study was a quasi-experimental design and the time and attention primary school pupils needed to be given to do the activities. Purposive and random sampling was used to select six government-approved private schools within the different parts of Makurdi local government area. The purpose for choosing the private schools was to avoid interruption of the research work through any unforeseeable strike actions of teachers of the public schools.

Instrumentation

Basic Science and Technology Achievement Test (BSTAT) was the instrument used in this study. This instrument was initially a 30-item multiple choice objective test, drawn from topics in the national primary school curriculum for Basic Science and Technology (NERDC, 2007) module five and Basic Science and Technology for Primary Schools book five by the Science Teachers Association of Nigeria (STAN, 2010). The items were drawn based on two of the four themes. The topics covered under the two themes were domestic animals, domestic animals as pets, reproduction in plants, acids, bases and soaps. The test items were presented to two professors and a senior lecturer in the science education for validation.

The items were rephrased or reconstructed by experts, after which it was trial-tested in a pilot study on a similar sample like the study sample for reliability estimate. The item difficulty index for each item was also analyzed using the scores of trial testing. The 25 items that scaled through the exercise were used to construct a table of specification to show the spread of items based on Bloom's taxonomy of objectives. Table 1 refers.

Table 1: Table of specification for the development of basic science and technology achievement test (BSTAT) based on Bloom's Taxonomy of Objectives

S/No	Contents		Knowledge 44%	Comprehension 36%	Application 20%	Analysis	Synthesis	Evaluation	Total 100%
1.	Domestic animals	16%	2	1	1	-	-	-	4
2.	Domestic animals as pets	20%	2	2	1	-	-	-	5
3.	Reproduction in flowering plants	20%	2	2	1	-	-	-	5
4.	Acids	20%	2	1	2	-	-	-	5
5.	Bases	8%	1	1	-	-	-	-	2
6.	Soaps	16%	2	2	-	-	-	-	4
	Total 100%		11	9	5	0	0	0	25

Basic Science and Technology Achievement Test (BSTAT) and the two-types of lesson notes were given to two professors and a senior lecturer in science education, Benue State University for critical examination. They were requested to study the objectives of the research and ascertain if the items had face and content validity; that is, if they both covered the topics to be taught, were grammatically correct and tested the objectives of the topics treated and were relevant to the research objectives and questions. They were also requested to make their recommendations as to whether they were suitable for primary school children to appropriately interpret and respond to. Similarly, they examined the suitability of the lesson notes in teaching inquiry-focused lessons and lecture lessons. Some of the tests items were rephrased for clarity and easy understanding to the primary school pupils.

The lesson notes for field-based inquiry method were also corrected to highlight their specific use as well as align with the expected format of lesson note preparation. The corrected instrument and lesson plans were used for item analysis in order to determine the difficulty index of the test items for Basic Science and Technology Achievement Test. Only 25 items out of 30 initial items constructed were found to possess the acceptable difficulty index of 0.3 to 0.7. The twenty-five items were then used for reliability analyses of the instrument using Kuder Richardson 21. The reliability estimate for BSTAT was found to be 0.87.

Data Collection Procedure

Six research assistant teachers were trained. The first phase of the training involved introducing the assistants to the lesson plans written by the researcher for use. The method was explained to them and the objectives of the research were made known to them. The teachers were allowed to privately study the six lesson plans and another meeting was conveyed for them to ask questions and have their difficulties and doubts cleared. The second phase involved taking a walk round the school premises to find out the possibility of teaching the individual lessons in

their respective school environments. The research assistants were involved in teaching, conducting test and marking of scripts.

The researchers along with the research assistants went round to conduct the pre-test in the six schools selected. The teachers were allowed to teach for six weeks, with occasional visits from the researchers to clarify issues and observe lessons. The experimental group was taught using the field-based inquiry method while the control group was taught using the conventional strategy. After the six weeks teaching the researcher went round the schools to administer the post-test having reshuffled the items in the BSAT. All teachers who participated in the teaching were duly motivated. Where pupils needed exercise books they were supplied with some. All the tests were administered and marked by the researchers and research assistants.

Results

Mean and standard deviation were used to answer the research questions. All the hypotheses were tested using Analysis of Covariance (ANCOVA) in agreement with Ali (2006) who asserted that it is a more rigorous statistics than Analysis of Variance (ANOVA) and is used for multi-group comparison. He further stated that ANCOVA is specifically used in a pre-test/post-test quasi experimental research design and/or when subjects are selected. When intact classes are used for treatment and control respectively, the gain score, the difference between the pre and post test means are analyzed to determine the statistical significance between and within groups, as covariates between pre-test and post-test.

Research Question 1

What is the difference in science achievement between pupils taught using field-based inquiry method and those taught using conventional strategy?

The result of data analysis to answer this research question is as presented in Table 2.

Table 2: Mean and standard deviations of pretest and posttest for experimental and control groups in BSTAT

Method	Test	N	Mean	Standard Dev	Mean Gain
Field-based inquiry method	Pretest	182	9.9945	2.6458	6.2198
	Posttest	182	16.2143	3.9238	
Conventional strategy	Pretest	147	7.9796	2.6650	3.5510
	Posttest	147	11.5306	3.5852	
Mean Difference	-	-	-	-	2.6688

Table 2 shows that the mean gain, that is, the difference between pretest and posttest means of the experimental group was 6.22. This mean gain was higher than the control group mean gain which was 3.55. This gives a mean difference of 2.67 in favour of the experimental group.

The experimental group achieved higher than the control group. To ascertain if the difference in achievement was significant, hypothesis one was tested.

Hypothesis 1

There is no significant difference between the mean achievement scores of pupils taught science using field-based inquiry method of instruction and those taught with the lecture method.

The results of data analysis to test hypothesis 1 is as presented in Table 3.

Table 3: ANCOVA for experimental and control group students' achievement

Source	Sum of squares	Df	Mean square	F	Sig of F
Corrected model	4116.860a	4	1029.215	143.101	.0001
Intercept	599.087	1	599.087	83.297	.0001
Pretest	2322.712	1	2322.712	322.948	.0001
Method	488.911	1	488.911	67.978	.0001
Error	2330.277	324	7.192	.	
Total	72056.000	329			.
Corrected total	6447.137	328			

a. R Squared = .639 (Adjusted R Squared = .634)

Table 3 shows that there is a significant difference between pupils' mean achievement of the experimental group and control group. The calculated F value 67.98 is significant at 1 and 328 degrees of freedom because P value of 0.001 is less than 0.05 (P=0.00<0.05) alpha value. The null hypothesis is therefore rejected. There is a significant difference between the mean achievement scores of pupils taught science using FBIMI and those taught with the lecture method.

Research Question 2

How do girls compare with boys in mean science achievement when exposed to the field-based inquiry method of instruction?

The results of data analysis to answer this research question is as presented in Table 4.

Table 4: Mean and standard deviation for pretest and posttest experimental male & female students in BSTAT

Sex	Test	N	Mean	Standard Dev	Mean Gain
Male	Pretest	103	9.7282	2.8395	6.7568
	Posttest	103	16.0485	3.9142	
Female	Pretest	79	10.3418	2.3419	6.0886
	Posttest	79	16.4304	3.9506	
Mean Difference	-	-	-	-	.6682

Table 4 shows the mean achievement scores of girls and boys (pupils) on BSTAT exposed to FBIMI. The mean gain for boys was 6.76 and that of girls was 6.09 with mean difference of 0.67 in favour of boys. This implies that girls achieved slightly higher than boys when taught by FBIMI.

To ascertain if this difference was significant or not, hypothesis five had to be tested.

Hypothesis

The mean achievement scores of boys and girls do not differ significantly when they are taught using the FBIMI.

The results of data analysis to test hypothesis 5 is as presented in Table 5.

Table 5: ANCOVA for experimental students' achievement by gender

	Sum of squares	df	Mean square	F	Sig of F
Corrected model	1474.584a	2	737.292	100.586	.0001
Intercept	334.144	1	334.144	45.586	.0001
Pretest	1468.066	1	1468.066	19.121	.0001
Sex	3.536	1	3.536	200.284	.488
Error	1312.059	179	7.330	.482	
Total	50635.000	182			.
Corrected total	2786.643	181			

a. R. Squared = .529 (Adjusted R Squared = .524)

Table 5 shows that value of F Calculated which was 0.48 is not significant at 1 and 181 degrees of freedom because P value was 0.49 and higher than 0.05 alpha value ($F_{1,\ 181}$ =0.48, P = 0.49> 0.05). Therefore the null hypothesis was not rejected. This implies that there is no significant difference between the achievement of boys and girls who are taught by the FBIMI. It then means that gender is not a significant factor in the mean achievement of boys and girls who were taught primary science by FBIMI.

Discussion of Findings

The study centered on the impact of a field-based inquiry method of instruction on pupils' science achievement. It is found that students in experimental group achieved higher than students in control group. That there was a significant difference in mean achievement between pupils exposed to field-based inquiry strategy and those exposed to conventional strategy. The implication of this is that method is a significant factor in pupils' achievement in basic science and technology. Thus pupils taught using the FBIMI performed better on the BSTAT than their counterparts who were taught using the conventional strategy.

The reason for the better achievement in science by the experimental group may be linked to the fact that pupils of primary five class are within the concrete operational stage. Tolman (2002) said, the concrete operational stage spans the elementary grades and calls for abundance of concrete experiences in learning. He advocated for the inclusion of opportunities for interaction with the physical and social environments to observe, manipulate, ask questions and experience science concepts. When pupils had opportunity and were encouraged by the teachers to observe on the field, manipulate concrete materials, discover differences in flower parts, soaps, animals and test for acid and bases in natural substances it boosted their curiosity and spurred them on to learn. At the end of the teaching session pupils had opportunity for development of process skills and carried out exercise on the Acquisition of Science Process Skills Test (ASPST) with much excitement. As such the pupils found the FBIMI suitable for learning and therefore achieved higher than their counterparts. This result also confirms what Martins (1994), I-shin (2009), Gbodi and Dantani (2009), Eronkhon (2004) found in their researches that inquiry method and hands-on method led to higher achievement in science among primary school pupils and even secondary school pupils. It also confirms the view of other authors such as Johnstone and Al-shuaihi, (2001); Schneider, Krajcik, Mark and Soloway,

(2002); Beerer,(2004); Wenning (2005); Millar, 2009) who said that inquiry based teaching results to critical thinking skills, positive attitudes and curiosity toward science and increased achievement.

It is also found that boys had a mean achievement test higher than that of girls with a negligible mean difference but the difference was found to be insignificant. This implies that gender is not a significant factor in pupils' science achievement in primary school. This means that both male and female pupils under the same condition will achieve equally well in science. The researchers assert that like many authors Gyuse, (1989) Okeke (2008), that gender differences in performance are caused by stereotyping of parents, teachers and society. Especially when children begin to turn into adolescent in Africa there is so much restriction about what a girl should do and what is not proper, this has a way of silencing many other desirable qualities even her academic performance. The authors also have consistently discovered no disparity in both acquisition of process or psychomotor skills as others call it and even cognitive achievement in primary school pupils. The findings of I-Shin, (2009) discovered no significant difference among males and females in primary 5 school pupils in their performance on hands-on activities. Gbodi and Dantani, (2009) also found no disparity exhibited in learning primary science among boys and girls who were taught using realia. Gyuse (1989) pointed out that the assertion that boys perform better than girls is an age long sex-stereotype but has not been confirmed by research at least not among primary school pupils. The so-called gender difference in mathematics and science achievement was not seen in the findings of this research. Manning, (1998); Lee, (2002) even wondered whether the differences were actually gender or age-specific or they are differences in attitudes or opportunities for mathematics and science. However, Pennet and Paret (2008) said that differences were discovered as early as kindergarten level.

Conclusion

Teaching method FBIMI is an important factor in science achievement of learners. The study revealed no gender disparity in science achievement with the use of FBIMI at primary school level. If the right method is employed for teaching it is hoped that both boys and girls will continue to perform equally well in their science career.

Recommendations

The following recommendations are made based on the findings of this research:

(i) FBIMI has shown to be suitable for pupils of primary school age therefore, Basic Science and Technology Curriculum by NERDC should include the use of outdoor, field-based experiences among its teaching and learning materials in column six of the Basic Science and Technology Curriculum. School supervisors should also ensure that teachers use it as teaching method for basic science and technology.

(ii) Teacher training institutions such as colleges of Education, University Faculties of Education should train pre-service teachers in the use of FBIMI

(iii) Proprietors should make school environment conducive for the use of FBIMI. Teaching aids like school gardens and animal farms should be necessary features of schools.

(iv) Teachers should not restrict themselves to the four walls of the classroom they should explore the environment as they lead pupils to study phenomena and materials on the field.

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ORGANIZATIONAL FACTORS AFFECTING EFFECTIVE UTILIZATION OF VIRTUAL LABORATORY PACKAGE ON SELECTED NIGERIAN SECONDARY SCHOOL PHYSICS CONCEPTS

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Abstract

The study examined the requirements needed for utilization of Virtual Laboratory Package (VLP) on selected Nigerian secondary school physics concepts. It also investigated some barriers that affect theeffective utilization of VLP in schools. Twenty four physics teachers were purposively selected to evaluate a virtual physics laboratory package using a 10-item questionnaire that was validated and found reliable for data collection. Two research questions were raised and answered. Data gathered from the administration of the questionnaire were analyzed using Mean and Standard deviation. Findings revealed that physics teachers agreed that effective use of virtual physics laboratory package in schools require adequate number of physics teachers, ICT staff, technicians who need regular in-service training for implementing technological innovations meant for teaching and learning(average mean response= 2.83 out of 5). It is also found that poor electricity supply, insufficient fund, low awareness and insufficient time allocated to physics practical in Nigerian secondary schools are parts of barriers to effective use of VLP in Nigerian secondary schools(average mean response = 2.56 out of 5). Based on the findings, it was recommended that government and relevant administrators should assist schools by providing needed manpower, training, fund and computer facilities in schools since the benefits of VLP in teaching and learning process are enormous.

Keywords: Barrier, Evaluation, Laboratory, Requirements, Technology, Virtual

Introduction

Information and Communication Technology (ICT) can be regarded as a strong weapon for sustainable development, empowering people for global competitiveness and tools that have contributed to the growth of all areas of human activity (Brakel & Chisenga, 2003). Virtual laboratory is one of the innovations in teaching and learning process that depend on the application and utilization of ICT tools. It is an interactive environment without real laboratory tools meant for creating and conducting simulated experiments (Babateen, 2011; Harry & Edward, 2005). It provides students with tools and materials set on computer in order to perform experiments saved on CDs or on web site (Babateen, 2011; Nunn, 2009).

The roles of virtual laboratory in teaching and learning process cannot be over-emphasized, it makes students become active in their learning and provide opportunities for students to construct and understand difficult concepts more easily (Gambari, *et al.*, 2012).Studies on effects of virtual laboratory on students' academic performance especially in practical based science subjects revealed the effectiveness of laboratory globally and thereforerecommended its utilization in teaching and learning process(Efe & Efe, 2011;Gambari, *et al.*, 2012; Mahmoud & Zoltan, 2009; Maldarelli, *et al.*, 2009; Tuysuz, 2010).

However, several computer learning packages have been developed, validated and found to be effective in teaching and learning of science-based subjects through various researches conducted in Nigeria are not being utilized in Nigerian schools owing to series of school factors which Bates (1995) referred to as organizational factors (requirements, barriers and technical capabilities).

Effective teaching with technology requires a higher skill level and this requires support, encouragement and investment for teachers by school administrators (Bates, 2000). The level of organizational support given to a technology is critical to its long-term success. Bates (2000) listed various organizational barriers to implementing technology, the greatest of which is lack of interest in using the technology for teaching by teachers. In addition, Irani and Telg (2002) stated that skills alone are not enough and that in many instances, instructors must change their teaching style as they learn how to operate or at least understand the operations of the technology they are using. Changes in administrative structures, policies and procedures, improved technical support for staff and students, and in-service training for staff will certainly be necessary to ensure effective adoption of technologies (Bates, 1995; Bates, 2000; Lambert & Williams, 1999; Irani & Telg, 2002).

Bates concluded that existing educational institutions were created to meet the needs of a society that is fast developing and that there is need for educational organizations that can exploit the new technologies to meet the needs of the twenty-first century. Adomi and Kpangban (2010) observed that adoption of learning technologies in Nigerian secondary schools is affected by limited school budget, inadequate manpower and limited ICT skills among teachers. Carnevale (2010) was of the opinion that for effective use of virtual laboratory, there is need for computers with special standard, need for specialized working staff, instructors and curriculum experts for designing and production. In terms of organizational issues, this present study will identify the barriers that are likely to hinder effective adoption of virtual physics laboratory package in Nigerian secondary schools as well as determine the essential requirements needed for the package to be selected for use in teaching and learning of physics experiments.

This study was therefore carried out to determine organizational factors (requirements, barriers and technical capacities within the school that affect effective utilization of an adapted virtual laboratory package on selected Nigerian secondary school physics practical concepts in schools.

Research Questions

The study provided answers to the following research questions:

(i) What requirements within the school do physics teachers consider essential to provide stability and support for the utilization ofvirtual laboratory package on selected physics concepts in Nigerian secondary schools?

(ii) What barriers within the school do physics teachers consider necessary to be addressed to ensure effective utilization of virtual laboratory package on selected physics concepts in Nigerian secondary schools?

Methodology

The study is a descriptive survey research. It involved the use of researcher's adapted questionnaire to elicit needed information from physics teachers and computer experts.

The population for this research consists of all secondary school physics teachersin Nigeria.Twenty- four physics teachers were purposively selected fromsix Federal Government Colleges in southwest Nigeriabecause of their relevance to the evaluation to be carried out.

Physics Teachers' Evaluation Questionnaire (PTEQ) was used for data collection.It was divided into two sections (Sections A & B). Section A were designed to collect demographic data of the respondents while Section B consist of 10 statements designed using 4-point scale (namely, 1 as Strongly Disagree, 2 as Disagree, 3 as Agree and 4 as Strongly Agree).Physics teachers used PTEQ to evaluate the requirements and barriers needed to be addressed within the school to ensure effective utilization of VPLP in schools.

The package was validated by two computer experts, four physics teachers and two educational technology experts. The questionnaire was validated by four secondary school physics teachers and its reliability was determined in a single administration on physics teachers in one of the schools within the research area but that was not considered for the main study and reliability coefficient of 0.90using Cronbach's Alpha formula.

Results

The data gathered was analyzed using Mean and Standard Deviation.A mean response below 2.50 was considered Disagree while a mean response of 2.50 and above was considered Agree. The analyses were used to answer the research questions.

Research Question 1: What requirements within the school do physics teachers consider essential to provide stability and support for the utilization of virtual laboratory package on selected physics concepts in Nigerian secondary schools?

Table 1: Physics teachers' meanresponse on requirement to enhance effective use of virtual physics laboratory package

S/N	Statement	N	SA	A	D	SD	Mean	S.Dev.	Decision
1	Effective use of virtual physics laboratory package in my school requires adequate number of physics teachers	24	7	9	6	2	2.87	0.37	Agree
2	Effective use of virtual physics laboratory package in my school requires adequate number of ICT staff	24	8	6	7	3	2.79	0.29	Agree
3	Effective use of virtual physics laboratory package in my school requires adequate number of technicians	24	9	8	4	3	2.95	0.45	Agree
4	Effective use of virtual physics laboratory	24	7	7	6	4	2.70	0.20	Agree

	package in my school requires adequate funding								
5	Physics teachers and ICT staff in my school need regular in-service training on technological innovations if virtual physics laboratory package will be effectively utilized in teaching and learning of physics	24	8	8	4	4	2.83	0.33	Agree
	Average Mean						2.83		

Table 1 reveals the mean response of physics teachers on the requirements that will enhance effective use of virtual physics laboratory package in secondary schools in Nigeria. The respondents agreed to all the five items with mean responses of 2.87, 2.79, 2.95, 2.70 and 2.83 respectively. The average mean of responses to all the items is 2.83, which is above 2.50. This indicates that physics teachers agreed that effective use of virtual physics laboratory package in schools require adequate number of physics teachers, ICT staff, technicians and regular in-service training of relevant staff in the school on technological innovations meant for teaching and learning.

Research Question 2: What barriers within the school do physics teachers consider necessary to be addressed to ensure effective use of virtual laboratory package on selected physics concepts in Nigerian secondary schools?

Table 2: Mean response of physics teachers on barriers to effective use of virtual physics laboratory package in schools

S/N	Statement	N	SA	A	D	SD	Mean	S. Dev.	Decision
1	Problem of poor electricity supply has to be tackled for virtual physics laboratory package to be effectively utilized in my school	24	8	7	6	3	2.83	0.33	Agree
2	Problem of insufficient time allocated to learning physics practical has to be tackled for students to learn experiments through virtual physics laboratory package	24	7	9	3	5	2.75	0.25	Agree
3	Poor orientation and	24	6	8	6	4	2.66	0.16	Agree

	lack of awareness of school administrators on technological learning packages has to be tackled for them to approve and encourage the use of virtual physics laboratory package in my school								
4	Poor computer skills of students in my school has to be tackled if they will embrace and learn through virtual physics laboratory package	24	3	4	8	9	2.04	0.45	Disagree
5	Insufficient funding of learning programmes and packages are to be tackled for virtual physics laboratory package to be effectively used in my school	24	7	6	4	7	2.54	0.04	Agree
	Average Mean						2.56		

Table 2 reveals the mean response of physics teachers on the barriers to effective use of virtual physics laboratory package in secondary schools in Nigeria. The mean response to each of the five items is above 2.50 except item 4 with a mean response of 2.04 which reveals that respondents disagree that poor computer skill of physics teachers is a barrier. The average mean of responses to all the items is 2.56. This indicates that physics teachers agreed that poor electricity supply, insufficient fund, low awareness and insufficient time allocated for learning physics practical in secondary schools in Nigeria are barriers within the school that will affect effective use of virtual physics laboratory package.

Discussion

The results of the analyses on requirements needed to ensure effective utilization of VLP in Nigerian schools indicated that physics teachers agreed that the effective use of the package requires proper funding, adequate physics teachers, ICT staff, technicians and regular in-service training of staff on latest teaching and learning technological innovations. This is in line with the recommendations of Bates (1995) and Bates (2000) that effective teaching and learning with technology requires a higher skill level and this requires support, encouragement and investment for teachers by school administrators. This finding is also in agreement with the recommendations of Carnevale (2010) that for effective use of virtual laboratory, there is need for computers with special standard, need for specialized working staff, instructors and curriculum experts for design and production. This finding also agrees with Farida and Ezra

(2005) that there is need for creation of awareness and changing of mindset by organizing workshops to promote the use of computer-based instruction.

Findings from this study also indicated that lack of awareness, poor funding, poor computer skills, insufficient time allocated to physics practical and epileptic power supply are barriers to effective use of VPLP in Nigerian schools. This is in agreement with the earlier finding of Irani and Teig (2002) that inability of teachers to operate or at least understand the operations of modern learning technologies to be used in schools, and finding of Bates (2000) that lack of faculty interest in using technology for teaching by administrators are barriers to effective utilization of learning technologies in schools. This finding also support the findings of Adomi and Kpangban (2010) who found that adoption of learning technologies in Nigerian secondary schools is affected by limited school budget, inadequate manpower and limited ICT skills among teachers.

Conclusions

It has been asserted that the major cause of non-utilization of learning technologies is as a result of lack of requirements and presence of barriers to effective utilization of such in schools. The result obtained from this study indicated that problems of poor funding, inadequate facilities, lack of awareness, incompetent manpower and poor maintenance culture are the major causes of not non-utilization of learning technologies in Nigerian schools which must be addressed.

Recommendations

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

(i) Government should assist schools by providing funds, computer facilities and competent manpower that can handle development, utilization and maintenance of learning packages such as virtual physics laboratory as their benefits in teaching and learning process are enormous.

(ii) Physics teachers should endeavor to develop competence in the use of technological applications meant for learning. This will further increase their knowledge on new innovations in ICT-Based instructional strategies;

(iii) Government and appropriate school authorities should embrace and support the use of virtual physics laboratory package in schools as this will enhance students'performance in physics; and

(iv) ICT staff in schools should be trained and acquainted with technological innovations. This will enable them develop, modify and maintain latest learning applications like, virtual physics laboratory package within the school system.

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PERCEPTION OF UNIVERSITY STUDENTS AND STAFF ON YOUTH VIOLENCE AND THE USES OF WIRELESS INTEGRATED NETWORK SENSOR (WINS) AS PRECAUTIONARY SECURITY MEASURE AGAINST STUDENT CRISIS IN NIGERIAN UNIVERSITIES: COUNSELLING IMPLICATION.

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Abstract

This study surveys the perception of students and staff on youth violence and uses of Wireless Integrated Network Sensor (WINS) as precautionary security measure to prevent student crisis in Nigerian Universities. The study samples was carried out on 300 students and staff drawn from various faculties across the two Universities, using stratified random sampling technique. Out of the above, 150 students and staff from Ahmadu Bello University, Zaria and the same number of students and staff were drawn from University of Abuja in all, 152 males and 148 females were used as subjects. The stratified random technique was used to group the selected participation on the basis of location and gender. A questionnaire titled "Uses of Wireless Integrated Network Sensor as Security Measure against Student Crisis" (UNWINSASMSC) validated by two experts was used to collect data from subjects. Data collected were analysed through the use of mean scores, mean ranking and t-test with reliability coefficient at 0.89. Two hypotheses were raised and it was found out that there was no significant difference between the subjects in their expressions on the uses of WINS as security measure against violence on campuses need to be counselled on illegal meetings, and negative consequences of unrest. It was recommended among other things, that WINS should be used as security measure so as to prevent violent activities and to maintain peace and tranquility in Nigerian universities.

Keywords: Youth Violence, Crisis, Wireless Integrated Network Sensor (WINS), Counselling Implication

Introduction

Youth violence, according to WHO (2002) is defined as the intentional use of physical force or power, threatened or actual exerted by or against children, adolescents or young adults, ages 10 – 29, which results in or has a high livelihood of resulting in injury, death, psychological harm; mal-development or deprivation. Youth violence is a problem world wide and it is so serious that it can even inflict harmful effects on victims and their families, friends and communities. From the report of the United States Institute for Peace (USIP) (2010), the scope of the problem of youth violence is immeasurable. Youth violence is generally described as a high-visibility, high priority concerned in every sector of society, including Nigeria, United Kingdom, United State, France, Kenya, Ghana, Afghanistan, Iraq, Iran, Israel, Syria, Hong Kong, among others. No community, whether affluent or poor, urban, sub-urban, or rural, is immune from its devastating effects.

Since the on set of Nigeria independence, there have been many of reported cases of violent crimes in University campuses, various communities all over the states; ranging from clashes among cult members, political clashes, land disputes, cultural violence, religious violence and tribal conflict; Boko Haram syndrome which started since October 2010 till now is the talk of the

day, in terms of its incidences, phenomenon and its devastating effects on lives and property. Boko Haram means "Western education is illegal". It is an Islamic movement which is otherwise known as "Jama'atu Ahlul Sunnati liddawatiwal-jihad, being the official name. Many youths today use Boko Haram to steal, harass, invade, loot and kill. Some are recruited to suicide bombing, and are lured and brain washed to believe that paradise is their home, after death (Njoku, 2012 &Usman, 2014).

According to Oxford Advanced Learner's Dictionary (2002:278), crisis refers to a time of great difficulty, particularly, when problems must be solved or important decisions must be made. In Nigeria many educational institutions lack adequate physical structures, facilities and instructional materials. Sporting activities are nothing to write home about, libraries do not have adequate books. Population of students are increasing at geometrical progression. The number of Nigerian universities have increased in number. When students are increasing in number without corresponding adequate facilities, it could lead to student crisis if appropriate security measures are not put in place (Usman, 2014). Thus, the aim of advocating the use of WINS as security measure in this paper becomes very pertinent as it can monitor activities on university campuses in Nigeria.

Wireless Integrated Network Sensor (WINS) is a wireless gadget which can provide monitoring and control capacity for transportation, manufacturing, health care, environmental monitoring, safety and security. WINS combine sensing (what abounds in a place or places), signal processing (shows signal on to the receiver), decision capacity (indicates the going-on), and wireless networking capacity in a compact low power system. (Cited in www.wikipedia.org/wiki/wireless-inte). According to Kaiser Gregory, Lars and Potttie (2014), WINS system combine micro sensor technology with low power sensor interface, signal processing and communication circuits. The need for low cost presents engineering challenges for implementation of these systems in conventional digital technology which can cover security or monitoring more than 1km with link bit rate over 100kbps.

While individual sensors have limited sensing region processing power, and energy, networking a large number of sensors, gives rise to a robust, reliable and accurate sensor network, covering a wider region. The network is fault-tolerant because many modes are sensing the same events. The modes cooperate and collaborate on their data, and this which leads to accurate sensing of events in the environment, including, a variety of ambient condition such as temperature, humidity, pressure and characteristics of objects or persons and their motion.

WINS can be used in schools, universities, military, health, and disaster relief scenario, can detect flood, forest or home disasters and habital exploration of animals. In addition to the above, patients can monitor their physiological data such as heart rate or blood pressure. The applications of sensor networks are endless, limited only by the human imagination (Marco, 2008). No wonder why WINS is some times described as miniature SPY plane compact geometry and lowcost. WINS can be embedded and distributed at a fraction of the cost conventional wire line sensor and actor systems, monitoring people and activities (Pottie and Kaiser, 2014).

Against this backdrop, WINS is being advocated in this study to monitor University campuses and students. To stir a crisis, students engage in writing protest letters to university authorities, complaining about high-handedness. They also post or display embarrassing posters and hand

bills requesting meetings and singing protests songs, harassing people holding responsible positions, carrying placards, boycott of lectures, blocking gates or highways, destroying lives and property. The use of functional Wireless Integrated Network Sensor (WINS) can relatively monitor all the above activities right from the outset to the end. Likewise, suicide bombers within the premises of campuses can be detected and can be trapped.

In such situations, WINS can be used to monitor effectively all university activities including those universities with many campuses. For instance, there are two or more (temporary and permanent campuses) in both universities of Abuja (Gwagwalada and Airport Road) and Ahmadu Bello University Zaria (Samaru and Kongo). Be as it is, WINS can effectively monitor relatively all activities going on from university entrance gate to exit gate. As WINS can monitor and can detect people's actions, it can equally serve as an evidence against criminals even in the court of law. Hence, the purpose of this study.

Statement of the Problem

Adewale (2005) reported that in recent times, students' unrest could be attributed to many reasons. According to him, there exist erosion of traditional values which cause students indiscipline, and students' crisis on University campuses. These lapses need to be addressed, by adapting various counselling strategies, being the intent of this study. Although, today's crises in universities may not only be attributed to government's fault for not providing adequate social amenities, the use of drugs, intoxicants and membership in secret cults see the vulnerability and volatility of universities as targets and fertile ground for attack. The installation of WINS being a watch dog can, monitor and can detect such invasions around university premises and the surrounding neighbourhood, and security agents can clampdown the suspects, instantly.

Edun and Abiodun (2011) confirmed incidences of students' crisis and mentioned that one of the worst incidents of students' violence where more than a dozen students were shot dead in June 2002 at the University of Nigeria, Nsukka, in the South-East of Nigeria. The armed gang entered the University of Engineering Faculty and three cars were stolen at a time. Dawes (2007) revealed that weeks before the Nsukka incident, a student leader on the campus of Lagos University, who headed a student anti-student cult campaign was stabbed to death by suspects of cultists. Another anti-cult activist, SegunOlusola, at the University of Nigeria, Nsukka, was abducted by gunmen in August, 2006. In November, 2014, University of Jos witnessed student unrest where two students were shot dead and many injured by the police. Recently, other educational institutions also witnessed Boko Haram invasion and attack particularly, in Borno, Adamawa, Yobe and Niger State. Hence, the reason to advocate, the use of Wireless Integrated Network Sensor (WINS) in this paper, as precautionary measure against any act of pandemonium on university campuses.

According to Maisamari (2005), a survey by an anti-campus-cult organizations indicated that there exist as many as thirty-six (36) different campus cults or confraternities operating across the length and breadth of Nigeria. From a low-key beginning (supposedly for noble, anti-colonial, anti-corruption and anti-oppression purposes), but campus cults have grown tremendously, not only in terms of numbers and memberships, but also in sophistication and barbarity. Some of these have negative influences on some youths which lead them to indulge in drinking alcohol unnecessarily, misuse of drugs, drug abuse, rape, vandalism, intimidation, hooliganism, theft, looting, truancy, examination malpractices, certificate forgery, sexual promiscuity, to mention but a few. In the tertiary institutions, Maisamari (2005) added that the

clandestine groups often identified are: the Mafia (Mafioso), the Ayes, the Bucaneers, the Maphites, the Pyrates/National Association of Sea Dogs, The Black Axe (Neo Blank Movement), The Viking, The Black Cat, the Black Beret and so on.

Some of the effects of secret cults on the campuses and on the society are insecurity, lawlessness, moral decadence, indiscipline, decline of moral, social and traditional values. It is based on the above devastating negative consequences of insurgency among youths that this paper dwelt on the use of WINS so as to monitor any sort of illegal clanderstine meetings organized by students to circumvent University policies. WINS could be used to clampdown suspects in order to maintain relative peace and security on campuses. This paper is also meant to advance counselling strategies to re-educate, enlighten, orientate university students and staff so as to cultivate the right attitude among youths in order to achieve the university objectives, being the ivory tower, the apex and citadel of learning.

Research Questions

(i) What are the uses of WINS in checking security measure as expressed by University students/staff.

(ii) What differences exist between students and staff of universities in their expression on the uses of WINS as precautionary security measure against student crisis on university campuses based on location?

(iii) Is there any difference between students and staff of universities of Abuja and A.B.U Zaria in their expression on the uses of WINS as precautionary security measure against students crisis on university campuses based on gender?

(iv) What are the counselling needs of students and staff on the uses of WINS on university campuses?

Research Hypotheses

(i) There is no significant difference between students and staff in their expression on the uses of WINS as precautionary security measure against students' crisis in universities based on location.

(ii) There is no significant difference between students and staff in their expression on the uses of WINS as precautionary security measure against students' crisis in universities based on gender.

Methodology

Sample and sampling technique: The sample for the study comprise 300 students and staff drawn from various faculties across the two universities using stratified random sampling technique. Out of the above number, 150 students and staff from A.B.U. Zaria and the same number of students and staff were drawn from university of Abuja in all, 152 males and 148 females were used as subjects. The stratified random technique was used to group the selected participant on the bases of location and gender.

The study collected data through the use of questionnaire titled "Uses of Wireless Integrated Network Sensor as Security Measure against Students Crisis" (UWINSSMSC). A well research constructed and content validated questionnaire (above with items drawn from the literature, was used to collect data. A test re-test method was used to ascertain the reliability of the instrument after an interval of two weeks and the use of Pearson Product Moment Correlation Statistics were employed to obtain a reliability coefficient of 0.89. Scoring was based on a

Likert-type scale of Strongly Agree, Agree, Strongly Disagree, Disagree responses, while the score of 4-3-2-1 was applied respectively from Strongly Agree to Strongly Disagree frequency count, percentages, mean score and mean ranking analysis were used, particularly to answer the research questions presented in the table below. The hypotheses were tested using the t-test analysis as applicable.

Results

Table 1: Distribution of respondents based on location

Location	Frequency	Percentage%
A.B.U Zaria	150	50
Uni Abuja	150	50
Total	300	100

Table 1 above shows that students and staff of A.B.U are 150 (50%) while 150 (50%) of University of Abuja students and staff belong to the second group.

Table 2: Distribution of respondents based on gender

Gender	Frequency	Percentage
Male	152	50.67
Female	148	49.33
Total	300	100

Table 2 reveals that 152 (50.67%) of the respondents are of the male folk thereby constituting the majority of the respondents while 148 (49.33%) are females gender.

Table 3: Rank order of the use of WINS as detective and security measure

S/N	Statement on the use of WINS as detective and security measure	Freq.	Mean (X)	Rank Order
1.	Installation of WINS has psychological implication because people will be scared to be monitored as suspects of disaster. Since WINS can monitor peoples entrance and exist on campus, suspects can easily be trapped which guarantees the smooth running of administration.	280	3.81	1st
2.	It can provide monitoring of illegal and land clandestine meetings among students and staff.	280	3.81	1st
3.	WINS combine sensing, signal processing, decision capacity and wireless networking capacity in a compact which is very efficient and effective in detecting and reporting activities of students and staff especially suicide bombers.	270	3.64	3rd
4.	It uses low power sensor interface, cost-effectiveness which ensures its long-life span as a detective wireless network.	265	3.48	4th
5.	WINS is relatively cheap in conventional digital technology which can cover security of the university community.	247	3.45	5th
6.	It can cover considerable distance, monitoring more than 1km with link bit rate over 100 kilobite per second (100kbps) and can detect intruders or suspects	245	3.24	6th
7.	WINS can network a large number of sensors giving rise to a robust, reliable and accurate sensor network, covering a wide region	240	3.21	7th

	including the university neighbourhood.			
8.	The network of WINS is fault-tolerant because many modes are sensing the same events going on within university and its neighbourhood.	240	3.21	7th
9.	It provides monitoring and control capacity for transportation especially transit buses used by students and staff.	239	3.18	9th
10.	Demonstrations, violence and the use of drugs and intoxicants by students can be relatively prevented.	238	3.10	10th
11.	WINS guarantees students' and staff safety and their property in offices and dormitories	235	3.02	11th
12.	Attempts by students, as regards vandalism and theft can be monitored, checked and can be reported in good time.	233	3.00	12th
13.	University community can be under surveillance twenty four hours (24hours), day and night (even during occasions) which ensures security and peace among students, staff and visitors	210	2.80	13th
14.	Students sneaking out of class without due process or jumping over university fence can be monitored.	206	2.62	14th
15.	WINS is very effective in the library in terms of security, distractions or disturbances.	200	2.55	15th

From the table above, the respondents had similar views towards the items identified as the uses of WINS as seen from the means table (all the means are 2.50 and above). However, the monitoring of people's entrance and exit (3.81), monitoring illegal and clandestine meetings among university students and staff (3.81) and sensing, signaling and networking suspected suicide bombers (3.64) were ranked highest as the major uses of WINS as precautionary security measure against insurgency on campuses; items 1, 3, 14 and 15 were ranked low accordingly.

Hypotheses Testing

Hypothesis one: There is no significant difference between students/staff in their expression on the uses of WINS as precautionary security measure against students' crisis in universities based on location.

Table 4: Means, standard deviation and t-value of respondents' expression on the uses of WINS as security measure against students' crisis on university campus

Variable	No	X	SD	df	t-obs	t-crit	P
A.B.U	150	26.18	3.75				
University of Abuja	150	24.89	3.10	298	1.32	1.96	NS

From table 4, it is evident that there was no significant difference in the perception of the participants based on location (t = 1.32; df = 298; P = NS).

Hypothesis two: There is no significant difference between students/staff in their expression on the use of WINS as precautionary security measure against students' crisis in universities based on gender.

Table 5: Means, standard deviation and t-value of respondents' expression on the uses of WINS as security measure against students' crisis on university campus

Variable	No	X	SD	Df	t-obs	t-crit	P
Male	152	28.05	5.43				
Female	148	29.17	5.74	298	1.54	1.96	NS
Total	300						

Table 5above indicates that there was no significant difference in the perception of the participants based on gender (t = 1.54; df = 298; P = NS).

Discussion

Judging from the results, the respondents had similar perception towards the items identified as the uses of Wireless Integrated Network Sensor (WINS) as seen from the means table, as all the means are 2.50 and above.

The major uses of WINS as revealed include: psychological implication it has on people when they realize that activities are being monitored from entrance to exit, they can be scared to torment trouble on the campus, as well as, prevention of illegal and clanderstine meetings among students and staff, which both have frequencies of 280, with 3.81 each as their mean scores. This finding corroborates with the findings of Dawes (2007) and Usman (2014) when they attributed that student gangsters, hold illegal meetings to torment crisis on campus and wireless network is capable of checking the tend.

Among the uses of WINS, the findings revealed that WINS combine sensing, signal processing, decision capacity and wireless networking capacity which is very effective in detecting and reporting activities of students and staff especially, the current saga of suicide bombers. The subjects also indicated that WINS can be used as a network sensor dictator because it uses low power sensor interface, which is cost effective; that WINS is relatively cheap; that it can cover considerable distance; and that it can network a large number of sensors giving risk to a robust, reliable and accurate sensors networking, covering a wide region of university neighbourhood. The above responses by subjects is in tune with Marco (2008) whose study discovered that WINS was used for monitoring criminals because of its low power sensor. It is also cheaper, than other devices using a large number of sensors which covers wide region when monitoring.

As the result indicated, other uses of WINS as shown by the respondents was that WINS is fault-tolerant because many models are sensing the same events going on within the university and control capacity for transportation, especially transit buses used by students and staff; that WINS can relatively prevent any act of demonstration or crisis on the campus; that it can guarantee students' and staffs' safety and their property on the campus; that WINS can prevent vandalism and theft as almost every thing is under the eagle eye of WINS; that the university using WINS is under surveillance twenty four hours even during occasions. The respondents also indicated that the uses of WINS also include the ability of the gadget monitoring students sneaking out of classes without due process or jumping over university fence. The last item

among the uses of WINS as identified by subjects used, was that WINS is very effective in the library in terms of security distractions. It can be re-echoed that each of all the listed uses of WINS above attracted means not less than 2.50, which authenticates the identified uses of WINS on campuses. The above responses accedes to the findings of Marco (2008), Kaiser (2007) Pottie & Kaise (2014) who disclosed that wireless network sensors virtually monitors every nook and cranny of an environment and refers to wireless network sensor as “an eagle eye” and “a miniature spy plane” and “limited by the human imagination”.

The indicators to these findings were that Nigerian citizens, particularly students are more security conscious than ever before because youths nowadays involve themselves in anti-social behavior within and outside university campuses.

This finding is in line with the views of Mgbekan (2004) who reported that the present day Nigeria is witnessing universities without adequate physical facilities and instructional materials, and population of students are increasing at geometrical progression and that students use these lapses as excuse to torment trouble and cause crisis in universities. Canadian International Development Agency (CIDA) (2007) found that some of the university youths had traces of involvement in drugs, alcohol and tobacco and initiate other students and involve themselves in university crisis. Edun and Abiodun (2011) confirmed that incidences of students’ crisis occurred in university of Nigeria, Nsukka, where a dozen of students were killed. Dawes (2007) revealed that students crisis occurred in University of Lagos, where many lives and poverty were destroyed. Maisamari (2005) also mentioned that campus cults have grown tremendously, not only in number but also in sophistication and barbarity. The recent crisis in the University of Jos, in 2014, where lives and property were destroyed, is a matter of concern. The recent invasion and attacks by Boko Haram armed gunmen and suicide bombers in educational institutions in the northern part of Nigeria such as Secondary Schools, Federal College of Education (Kontagora) and State University, Damaturu in Yobe State, all call for the use of WINS as preventive security measure against such attacks. There is need not only to install WINS on the campus but also, to re-shape the attitudes of these youths, be given special orientation, so as to make them have a re-think over their anti-social behaviours. Professional counsellors should be involved to adopt various counsleling strategies such as behavior modification, and entrepreneurship education so as to make our youths adjust positively and to face the realities of life. Hence, the reason for this study.

Counselling Implication

The essence of installing Wireless Integrated Network Sensor (WINS) is to monitor relatively all the activities going on, on university campuses as WINS serves as a watchdog and precautionary security measure against students’ crisis. The result of this study reveals among others, that by installing WINS on the campus, students, staff and visitors would be psychologically cautioned and scared to indulge themselves in tormenting trouble on the campus. In this respect, counsellors should not only suggest the use of WINS on the campuses but also to give orientation to students and staff on the installation of WINS and its uses on the campus as WINS can monitor people from entrance to exit. The use of WINS in Purdua University, University of California, Los Angeles, (India) University of Southern California, Cornell University (New York), Cochin University of Science of Technology attest to the fact that WINS can serve as watchdog and security measure against insurgency (cited in www.wikipedia.org/wiki/wireless-inte).

The result also indicated that WINS can provide monitoring of illegal and clanderstine meetings among students, particularly those of them who are cultists and use flimsy excuses to organize demonstrations, without seeking ways of resolving issues through dialogue and reconciliation approaches. Counselling implication in this respect, is that students need to be given adequate orientation incessantly, so as to make students understand the dangers of cultism, the use of hard drugs and general consequences of crisis in any community. Dawes (2010) and Usman (2014) advocated that Nigerian counsellors should adopt counselling approaches as being practiced in developed countries such as effective orientation and re-orientation of youths, life skills acquired in social development programmes aimed at building social, emotional and behavioural competences, that could prevent youths from illegal meetings, anti-social behavior and terrorist attacks. Minnisota University Report (2013) revealed that universities are hot spots for bomb attacks, drug smuggling, robbery, kidnapping, murders, exam malpractices, rape, smoking, alcoholism and acts of vandalism which WINS can monitor and give feedback for necessary action.

Counsellors should adopt value orientation and re-orientation to our youths so as to change their negative attitudes, value orientation, According to Academics' Dictionary of Psychology (2006), value orientation is an ideological, political, moral aesthetic and other foundations, for personal assessment of an attitude to surrounding reality. Value re-orientation on the other hand, is referred to, as a revisit of the process of orientation with new ideas, innovations, policies and regulations and attitude to surrounding institution. Usman (2014) suggests that in order to change negative attitude of youths in terrorism, counsellors should embark on value clarification. According to him, it is an identification through selection from alternatives of available values in respect of genuineness of cultural tradition, theories, ideologies, work ethics, policies and roles established in any environment are the guiding principles. University-community based orientation should be embarked upon which will involve, students, staff including junior workers, by sensitizing them on the uses of WINS and the new attitudes to be cultivated on campuses.

The learning theory of Skinner (1957) cited in Usman (2014) shows how positive reinforcement increases the possibility of an operant, and how extinctions can be introduced for the adoption of withdrawal of positive reinforcement. This strategy is used to change students' maladaptive behaviours. Cognitive restructuring is another technique, which is used to probe "the students' internal frame of reference", to discover where attitude, ideas and feelings went wrong, and gradually restructure with the students, their thinking faculty which will in turn affect the overall exhibited behavior (Oomen, 2011). UNESCO (1974) cited in Usman (2014) posits that, in areas of youth violence, peace education which preempts conflict, can prevent conflict outbreaks, resolving conflict outbreaks and resolving conflict through dialogue and promotes culture of peace in university environment.

Conclusion

This study has outlined some characteristics and incidences of youth violence, some anti-social behaviours and associations, organized in various universities which call for security measure against such violence. It also explained the vulnerability and volatility of university community in terms of organizing illegal meetings,tormenting troubles, causing pandemonia and attacks on campuses. Based on the above phenomena, the use of Wireless Integrated Network Sensor (WINS) is advocated, for its installation on campuses monitor, detect and report relatively all

activities, so as to serve as security measure against insurgency and to save university communities from unnecessary embarrassment and disruption of administrative functions.

The two hypotheses formulated and tested revealed that the installation of WINS among other things, has the capacity to detect all activities going on, on university campuses and can as well monitor and report cases of predisposing illegal meetings, suicide bombers, use of hard drugs and attempts to organize riots and demonstrations on campuses. Based on this, counselling strategies have been proposed for the need of counsellors to change negative attitude of youths for positive thinking and adjustment through dialogue, peace education, value orientation, value re-orientation and value clarification so as to maintain zero tolerance of youth violence and to make universities free zones of insurgency.

Recommendations

The findings from this study depicted that youth violence is a phenomena which happens every where all over the world including university communities. This calls for precautionary security measure against such social vices. Based on this, the following recommendations are proffered viz a viz:

(i) Universities should make effort to install security measures, particularly, Wireless Integrated Network Sensor (WINS) in order to monitor and to detect suspects tormenting trouble, victims of hard drug users and possession of dangerous weapons on campuses.

(ii) University authorities should enlighten students and staff on the objectives of installing WINS on campuses.

(iii) When students are well disciplined in order to avoid destruction of WINS by students (if available)

(iv) Resource persons among senior officers of the police and the army should be invited to give talks on the implications of such vandalistic attitude and the need to provide precautionary security measures such as WINS against crisis in the society.

(v) The university authorities should ensure constant and regular supply of electricity so as to make WINS functional and to meet the desired goals and objectives of its installation.

(vi) The required manpower for the operation, stand-by generators should be provided in case of electricity failure. Functionality and management of WINS should be provided and be given adequate technical training for the management of WINS.

(vii) Insurance companies for WINS should be involved for the purpose of security, accident, and other eventualities.

(viii) The university authority should give special orientation to the university traditional security agents on the installation of WINS gadget. Sanctions against its damage should be categorically stated. They should also be enlightened on the delicacy, sensitivity and fragility of the electronic gadget and implications of these when defaulted.

(ix) University should make techniques available on the campus so that immediate repairs are done whenever WINS is faulty or has technical problem.

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EFFECTS OF COMPUTER ASSISTED INSTRUCTIONAL PACKAGE ON GENDER ACHIEVEMENT AND RETENTION IN GEOMETRY AMONG JUNIOR SECONDARY SCHOOL STUDENTS IN MINNA METROPOLIS

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Abstract

This study examine the effectiveness of Computer- Assisted Instructional package (CAIP) on gender achievement and retention in geometry among junior secondary school students in Minna Metropolis. Three research questions were raised and three null hypotheses were formulated. The study adopted the pre-test-posttest - control group design. A random sample of eighty (80) students was drawn from four junior secondary schools in Minna Metropolis. The researcher developed computer assisted instructional package on geometry which was used as treatment instrument for experimental group. The instrument for data collection was Geometry Achievement Test (GAT). A 40-items multiple-choice objective type achievement test covering ten selected topics in Geometry was used to collect data. A reliability coefficient of 0.75 was obtained from test-retest data using Pearson's Product Moment Correlations coefficient. The t-test statistic was used to analyzed the data. The findings revealed that male students performed better than female students when taught geometry with CAI. It was recommended among others that there should be the provisions of adequate teaching and learning materials particularly those that have to do with information and communication technology by the government or other relevant stakeholders in order to improve the use of computer devices for meaningful learning of mathematics.

Keywords: Computer Assisted Instruction, Achievement, Retention, Gender and Geometry

Introduction

Progressive education in science, technology and mathematics for male and female citizens is the most effective developmental investment any society can make to attain social stratification with high powered technological advancement. Mathematics is central to this development and it is an intellectually stimulating subject that affects every facets of human activity such as politics, economy, science and technology. Salman (2005) describes it as a precursor of scientific discoveries and inventions. Mathematics is the science of space and numbers (Odili, 2006). The study of space is called Geometry; the study of numbers is called Arithmetic, while the hybrid of Geometry and Arithmetic is called Algebra. For proper understanding of science, mathematics play a major role, hence is referred to as the queen of all sciences (Odili, 2006). In another development, Abdullahi (2004) observed that among the factors contributing to students' low enrolment and performance in physics is poor mathematical ability.

The importance of mathematics is underlined by the fact that it is a compulsory subject and a basic requirement for admission into tertiary institutions for any course of study in Nigeria. According to Punch (2004), the subject is needed for technological development of Nigeria and that the future of national industrial and technological development hinges on Mathematics,

which is regarded as the pillar of science and technology. Nigeria is facing an uphill task in producing requisite engineers, scientists and technologists as a result of poor base for Mathematics to thrive. Therefore, Geometry is an important component of mathematics that deals with the study of spatial relationship. It is connected to every strand in the mathematics curriculum and to a multitude of situations in real life (Naidoo, 2009). Geometric figures and relationships have played an important role in the society, especially in things that are aesthetically pleasing. Well-constructed diagrams allow us to apply knowledge of geometry, geometric reasoning, intuition to arithmetic and algebraic problems. The use of a rectangular array to model the multiplication of two quantities, for instance, has long been known as an effective strategy to aid the visualization of the operation of multiplication. Other mathematical concepts which run very deeply through modern mathematics and technology, such as symmetry, are most easily introduced in a geometric context. Whether one is designing an electronic circuit board, a building, a dress, a bookshelf or a newspaper page, an understanding of geometric principles is required (Naidoo, 2009)

In spite of the importance and popularity of mathematics among Nigerian students, performance at junior secondary school level had been poor (Iwendi, 2012). The major problems faced by most students are the inability to remember what they have learnt. This problem is often caused by too much theoretical expressions or formulae by the mathematics teachers while learners remain passive listeners (Odili, 2006). Therefore, to remove passiveness and ensure smooth interaction in the classroom, Computer Assisted Instruction package could be used to transform Mathematics classroom in to different kinds of rich memorable experiences and thus reduce boredom and forgetfulness.

Retention is an act of retaining something or the condition of being retained, or ability to remember things. In relation to teaching and learning, it means the act of remembering what has been taught in the classroom. Correct and effective use and/or application of whatever one had learnt would aid retention Mkpa (1981) states that retention is the continued capacity to behave in particular way that has been learned. Also Obodo (1990) asserts that retention is measured in collaboration with achievement. His study on differential effects of three teaching models on performance of Junior Secondary School students in some algebraic concepts showed equal retention. This indicates that each of the models, that were effective in students' achievement in algebra, could as well help the students to retain algebraic concepts effectively. Eze (2002) therefore, posits that retention is a crucial construct that most classroom teachers strive to maximize among their pupils.

Gender issues have been linked with performance of students in academic task in several studies but without any definite conclusion. Odok (2006) found that there is no significant relationship between gender and achievement in number and numeration, statistics and algebra, but a weak relationship between gender achievement in geometry and trigonometry. Also, Amelink (2009) indicated that male students performed better in geometry and measurement, while numbers and operations were better handled by female students.

Mathematics at all levels of Education especially junior secondary schools continues to remain a serious problem to students due to the abstract nature of the subject. This has led to high rate of failure in public standardized Examinations (WAEC/NECO) in secondary schools. The lack of understanding in learning geometry often causes discouragement among the students, which invariably lead to poor performance in geometry. A number of factors have been put forward to

understand why geometry learning is difficult, these are geometry language, visualization abilities, and ineffective instruction (Cangelosi, 1996) in Alhassan (2013)

However, as a result of the above backdrop the researcher found it necessary to search for appropriate approach that will be suitable and may enhance academic achievement and retention in geometry. Thus, this study examine the effects of Computer Assisted Instructional package on male and female students' achievement and retention in Geometry among Junior Secondary School Students in Minna metropolis, Niger state

Purpose of the Study

The purposes of the study are to:

(i) examine the effect of computer assisted instructional package on student's achievement in geometry between the experimental and control groups

(ii) examine the influences of gender on the academic achievement of students when taught geometry using Computer Assisted instructional package.

(iii) find out the influence of gender on the mean retention score of students taught geometry using Computer Assisted instruction Package.

Research Questions

The following research questions are addressed in the study:

(i) Is there any difference in the mean achievement scores of students taught geometry using computer assisted instructional package and those taught the same geometry using lecture method?

(ii) Will there be any difference in the mean achievement scores of male and female students taught geometry with Computer Assisted Instructional package?

(iii) Will there be any difference in the mean retention scores of male and female students taught geometry using Computer Assisted Instructional package?

Null Hypotheses

The following null hypotheses were tested at 0.05 alpha levels:

HO_1: There is no significant difference in the mean achievement scores of students taught geometry with computer assisted instruction and those taught with lecture method.

HO_2: There is no significant difference between the mean achievement scores of male and female students taught geometry using CAI package.

HO_3: There is no significant difference between the mean retention scores of male and female students that are taught geometry using CAI package.

Methodology

The research design for this study was a pretest-posttest control group design. The target population was 4,383 secondary school students in Minna Metropolis, Niger state. Simple random sampling technique was adopted to select four junior secondary schools for experimental and control groups, out of twenty (20) public schools in Minna Metropolis. Hat-draw method was used in the selection process.

The sample for this study was made up of 80 students, boys (n=40) and girls (n=40) using stratified random sampling techniques. A breakdown revealed that the experimental group

consist of 40 students with an equal gender balanced of boys (n=20) and girls(n=20). The experimental groups was taught geometry using Computer Assisted Instructional package (CAIP) which covered ten topics

The research instrument for data collection for the study was Geometry Achievement Test (GAT). This is an achievement test drawn from past Junior Secondary School Certificate Examination/National Examination Council (JSSCE/NECO) question papers (2006-2011). The test consisted of forty (40) multiple choice questions with four options. The test carried a total of one hundred (100) marks, with each correct answer weighed 2.5 marks. The topics taught during the study were introduction to geometry, quadrilateral, polygon, Areas of plane shapes, Areas of Triangle, Areas of Rectangle, Areas of Parallelogram, Sum of interior Angle of a polygon, Surface area of a Cylinder and Surface area of a Cone. The instruments for this study are Geometry Achievement Test (GAT) and Computer Assisted Instructional package (CAIP).

Computer Assisted Instructional package (CAIP) on geometry is a self-instructional and interactive package. It contained ten lessons structured in units, each unit lasted 40 minutes. The topics covered in the package were introduction to geometry, quadrilateral, polygon, Areas of geometric shapes, Areas of Triangle, Areas of Rectangle, Areas of parallelogram, Sum of interior angle, surface area of a Cylinder and surface area of a cone. The topics were drawn from the geometry contents of Nigerian junior secondary school Mathematics curriculum for JSSII.

The computer Assisted Instructional Package (CAIP) and Geometry Achievement Test (GAT) were validated by three (3) experts from mathematics/computer department and two mathematics teachers from junior secondary schools in Minna metropolis validate the contents of the instruments. They considered the audibility, simplicity of the package as well as its suitability for the level of the subjects. They verified the extent to which the items of each unit were considered to testing the topic they were meant to test, and check the possible errors and suggested answers. Base on the comments, corrections and advise of the experts, the original package was edited by the researcher for the final draft. The package, thus validated was then used for the study. A pilot test was conducted using test-retest method to ascertain the reliability of the Geometry Achievement Test instrument. The instrument had reliability coefficient of 0.75 using Pearson Product Moment Correlation coefficient

The study covered six (6) weeks. There was an orientation with the mathematics teachers and the students in each sampled school. This training and demonstration lasted for a week. When the teachers and students were adequately briefed, trained and have demonstrated competency on operational guide to instruction, the study then commenced. The experimental groups were exposed to Computer Assisted Instructional package which had been installed on desktop computer. After two (2) weeks of administering the post-test, the same test was administered for the measurement of post-posttest (retention) of the students in geometry. The GAT was given as the retention test. The retention test was administered the same manner post-test was administered. The t-test was used to test all the Null hypotheses using Statistical Package for Social Sciences (SPSS) version 16 at 0.05 alpha levels.

Results

Table 1: t-test comparison of Experimental and control group on pre-test Scores

Group	N	df	Mean	SD	t-value	P-value
Experimental Group	40		33.95	8.36		
		78			0.19	0.17^{ns}
Control Group	40		33.55	8.20		

ns: Not significant at the 0.05 level

Table 1 shows the t-test result of the pre-test for the experimental and control group. From the table, the p-value of 0.17 is not significant. This indicates that there is no statistically significant difference between the mean score of the experimental and control group. This therefore, meant that the students in both groups were found to be equivalent with respect to their prior knowledge of the concept of geometry in Mathematics.

HO_1: There is no significant difference in the mean achievement scores of students taught geometry with computer assisted instruction and those taught with lecture teaching method.

Table 1: t-test comparison of experimental and control group on posttest scores

Group	N	df	Mean	SD	t-value	P-value
Experimental Group	40		65.63	18.82		
		78			2.19	0.03*
Control Group	40		56.93	16.60		

*Significant at the 0.05 level

Table 2 shows the t-test comparison of the posttest mean scores of experimental and control groups. The p-value of 0.03 is significant at 0.05 alpha level. Hence, HO_1 was rejected. The experimental group exposed to CAI performed significantly better than the control group that was taught with lecture method. It could be deduced from the result that the use of CAI had a positive and significant impact on the performance of JSS student in mathematics.

HO_2: There is no significant difference in the mean achievement scores of male and female students taught geometry with computer assisted instruction.

Table 3: t-test comparison of mean achievement scores of male and female students

Group	N	df	Mean	SD	t-value	P-value
Male	20		74.00	15.94		
		19			6.31	0.001*
Female	20		52.00	17.73		

*: Significant at the 0.05 level

Table 3 shows the t-test comparison of the post-test mean achievement score of male and female student. From the table, the p-value 0.001 is significant at the 0.05 level. This indicates that there is statistically significant difference between the mean score of male and female

students. Therefore, the Null hypothesis was rejected. Male students performed significantly better than their female counterparts.

HO_3: There is no significant difference between the mean retention scores of male and female students taught geometry with computer assisted instruction.

Table 4: t-test comparison of mean retention scores of male and female students

Group	N	df	Mean	SD	t-value	P-value
Male	20		64.00	18.75		
		19			3.93	0.001*
Female	20		52.50	17.58		

*: Significant at the 0.05 level

Table 4 shows the t-test comparison of the mean retention scores of male and female students. The p-value of 0.001is less than 0.05 alpha value. Therefore, the research hypothesis was rejected. Hence, there is significant difference between the mean retention score of male and female students taught geometry with computer assisted instruction in favour of male students.

Discussion of Findings

Finding of this study shows that there is significant difference between the achievement of male and female students taught with CAI .The finding is in agreement with the finding of Odok (2006); Vole (2009) and Amelink (2009) who found significant difference between male and female students taught with CAI. However, this findings is in contrast with the earlier findings of Bello (1990); Etukudo (2002) ; Spence (2004) and others who found no significant difference between male and female students achievement when expose to CAI.

The finding is in agreement with the findings of Danmole (1998), Etukudo (2002) and others who found that male students performed better than female students when taught geometry with CAI. Contrary to the finding of Bello (1990); Nussaum (2000) who observed that there is no significant difference between male and female students in retention when taught with CAI.

Conclusions

The use of CAI package significantly enhances the achievement and retention of students in geometry. This is because computer allows flexible learning approach in the classroom. This ensures practical and meaningful learning. Also, the use of computer assisted instructional package enhance the performance of male students over the female counterparts.

Recommendations

On the basis of the findings from this study, it is recommended that:

(i) Secondary school Mathematics teachers should be encouraged to explore the application of computer assisted instruction in their classroom instruction in order to ensure effective teaching and learning.

(ii) There should be the provisions of adequate teaching and learning materials particularly those that have to do with information and communication technology by the government or other relevant stakeholders in order to improve the use of computer devices for meaningful learning of mathematics.

(iii) Computer programmers and teachers should be encouraged to develop and produce soft ware's which will be used to improve the application of methods of teaching.

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ATTITUDE AND CHEMISTRY STUDENTS' ACADEMIC PERFORMANCE IN SENIOR SECONDARY SCHOOLS IN NORTH-CENTRAL, NIGERIA

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Abstract

The importance of science and technology underscores the need to ensure that more and more students are encouraged to specialize in science-based courses. This is important especially when concerns are being raised on the declining interest of secondary school students in science. This study was carried out to determine the relationship between Chemistry students' attitude towards learning Chemistry and their academic performance in senior secondary schools in North-Central, Nigeria. The study was a descriptive ex-post facto research of the survey type. The sample for the study comprised of one thousand, one hundred and fifty (1150) senior school III (SS III) Chemistry students in the North-Central geopolitical zone of Nigeria. The research instrument used for the study was a researcher-designed questionnaire, entitled Students' Attitude to Chemistry Questionnaire (SACQ) which had a reliability coefficient of 0.72. Data were collected by direct administration and analyzed using frequency count, percentage, and Pearson Product Moment Correlation, while chemistry students' grade in joint mock examinations conducted by states in North-central Nigeria in 2012 represented their academic performance. The finding of the study revealed that the attitude of the students towards the learning of Chemistry in senior secondary schools in North-Central Nigeria was positive, and that it correlated with their academic performance in the subject. It is recommended among other things that Chemistry teachers should device appropriate instructional methods that would sustain and even improve the attitude of the students towards the learning of Chemistry.

Keywords: Attitude, Chemistry Students, academic Performance, Senior Secondary Schools

Introduction

The declining students' interest in science courses and careers is a worldwide concern. Since students' attitudes toward science affect course and career choices, as science becomes ever more deeply embedded in our everyday life, how ordinary people perceive science is attracting growing attention not only from the scientific community, but also from social scientists (Bak, 2001). One of the key factors in learning science is students' attitudes and the development of positive attitudes towards science can motivate students' interest in science education and science related careers (George, 2006).

Baron and Byrne (1994) revealed in their argument that attitudes dictate individual's perception of the world and their social interaction. An individual should have new experiences and information, to change his/her attitude towards an object, this means that human beings are not born with attitudes; they learn them afterwards from experiences, knowledge and skills gained. However, attitude is not static; it changes in the course of time (Erdemir & Bakiri, 2009).

According to Oskamp and Schultz (2005), an attitude may be defined as a predisposition to respond in a favourable or unfavourable manner with respect to a given attitude object. Attitudes associated with learning science appear to affect students' participation in science as a subject and had influence on performance in science (Jegede, 2007). Attitudes are acquired through learning and can be changed through persuasion using a variety of techniques. Attitude, once established, help to shape the experiences the individual has with object, subject or person. Although attitude changes gradually, people constantly form new attitudes and modify old ones when they are exposed to new information and new experiences (Adesina & Akinbobola, 2005).

Chemistry teaching can only be result-oriented when students are willing and the teachers are favourably disposed, using the appropriate methods and resources in teaching the students. Attitude is viewed as a set of affective reactions towards attitude object, derived from concepts or beliefs that the individual has concerning the object, and predisposing the individual to be having in a certain manner towards the object (Abba, 2000).

Students' beliefs and attitudes have the potential to either facilitate or inhibit learning (Yara, 2009). The National Policy on Education (FRN, 2004) also stated in section 18(d) as one of its goals, the need to "mould the character and develop sound attitude and morals in the child (p. 9). Papanastasiou (2001) reported that individuals who have positive attitude towards science tend to perform better in the subject, because the affective behaviours are strongly related to performance.

The benefits of positive attitudes to learning according to Glover (2010) include: self-motivation, disappearance of any problem one may experience, better self-esteem, elimination of stress, increased creative thinking and performance of success. Oluwatelure and Oloruntegbe (2010) examined the attitude of students towards Biology and Chemistry. The result of their study revealed that performances of students in science are a function of their attitudes to the subject.

Escalona (2005) determined the correlation between attitude toward Chemistry and Chemistry performance of second year students who were enrolled in Chemistry at John B. Lacson Colleges Foundation in Bacolod. The result showed that there was a positive and significant relationship between the students' attitude towards Chemistry and Chemistry performance. Similarly, a study conducted by Oyedokun (2000) revealed a significant relationship between students' attitude and their school academic performance. However, Ma and Kishor (1997) after analyzing the correlation of attitudes and performances in classical studies found that this correlation was not statistically significant.

Statement of the Problem

Generally, the academic performance of Nigerian candidates in School Certificate Chemistry has not been encouraging over the years. For instance, Figure 1 presents the performance of Nigerian students in Chemistry in the May/June West African Senior School Certificate Examinations (WASSCE) conducted by the West African Examinations Council between 2006 and 2012.

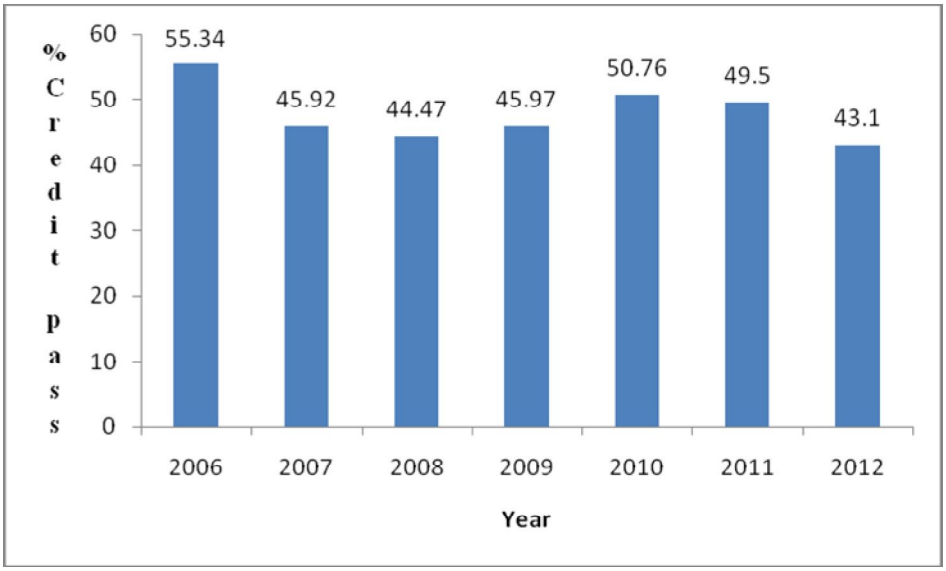

Fig 1: Graphical representation of WASSCE candidates' performance in Chemistry between 2006 -2012

A critical examination of figure 1 shows that the highest performance (55.3%) was in the year 2006 while the lowest performance (43.1%) was in the year 2012. Going by the submission of Jegede (2007) that attitude had influence on students' performance in science, one of the factors that may be responsible for the unsatisfactory performance of students in Chemistry may be their attitude towards the learning of the subject. Therefore, this study sought to find out if there was any relationship between students' attitudes toward learning Chemistry and the academic performance of senior secondary school Chemistry students in North-Central, Nigeria.

Purpose of the Study

The purpose of this study was to find out the relationships between students' attitude to learning chemistry and academic performance of Chemistry students in senior secondary schools in North-Central, Nigeria. Specifically, the study determined:

(i) the attitude of senior school Chemistry students towards learning of Chemistry in North-Central, Nigeria.

(ii) the relationship between Chemistry students' attitude towards learning Chemistry and their academic performance in the subject.

Research Questions

The following research questions were raised in the study:

(i) What is the attitude of senior school Chemistry students towards learning of Chemistry in North-Central, Nigeria?

(ii) What is the relationship between students' attitude towards learning Chemistry and their academic performance in the subject in North-Central Nigeria?

Research Hypothesis

HO_1: There is no significant relationship between secondary school students' attitude towards learning Chemistry and their academic performance in the subject in North-Central, Nigeria.

Methodology

The population of the study was all Chemistry students in the Senior School Three (SS III) in North-Central, Nigeria. The selection of students cut across Kogi, Kwara and Niger States within this region. Stratified random sampling was used to select One thousand, two hundred (1200) SS III Chemistry students in the three states for the study.

The instrument used for the study was a students' attitude to Chemistry (SAC) questionnaire constructed by the researchers in consultation with existing related literature. The items were drawn from related concepts which are important components of attitude considered in this study. They were 4-point Likert attitudinal scale items with response modes of strongly Agree (SA), Agree (A), Disagreed (D) and Strongly Disagree (SD) which attracted 4, 3, 2 and 1 scores respectively.

The questionnaire was validated by three lecturers in the Department of Science Education, University of Ilorin, Ilorin, Nigeria. The reliability of the questionnaire was determined using test re-test method of two weeks interval, in which the questionnaire was administered to thirty Chemistry students from another school not involved in the main study. The data obtained was subjected to Pearson Product Moment Correlation Statistic. A reliability coefficient of 0.72 was obtained.

One thousand, one hundred and fifty 1150 correctly filled copies of the questionnaire were selected for data analysis. The data obtained were subjected to descriptive statistics of frequency counts, mean, percentage and standard deviation. Pearson Product Moment Correlation was also employed to determine if there was correlation between the attitudinal scores of the respondents with their performance scores in the Joint Mock Chemistry Examination conducted in Kogi, Kwara and Niger States, Nigeria in 2012.

Results

The data obtained in respect of each of the research questions are presented and explained as follows:

Research Question 1: What is the attitude of senior school Chemistry students towards learning of Chemistry in North-Central, Nigeria?

Table 1 presents data on the attitude of students toward learning Chemistry among the respondents. A mean range of 2.5 to 4.0 (4.0 is the maximum) was taken to represent positive attitude, while a mean of less than 2.5 was taken to represent negative attitude.

Table 1: Summary of ranks of mean attitude scores of students towards learning of Chemistry among senior school Chemistry students in North-Central Nigeria

S/N	Item	Mean	Rank	Attitude of students
10	I like to study chemistry because it helps me discover the importance of science for the development of man and society.	3.24	1	Positive
20	Chemistry is an appropriate subject for developing scientific literacy.	3.23	2	Positive

6	I prefer working in group in chemistry class because group work helps the student to develop scientific attitude.	3.21	3	Positive
27	I have regard for those who study chemistry as a career in higher institution.	3.20	4	Positive
3	I need chemistry in my course of study.	3.19	5	Positive
11	Studying chemistry leads the students to think objectively and helps them develop the spirit of enquiry.	3.18	6	Positive
18	I believe that chemistry teachers should be specially trained before they go to class to teach.	3.18	6	Positive
19	Relevant materials from our environment can be used to learn chemistry.	3.17	8	Positive
9	I study chemistry because it is compulsory for science students in the secondary school certificate.	3.15	9	Positive
2	Chemistry is an interesting subject to learn.	3.13	10	Positive
28	I don't miss chemistry class because it is always interesting.	3.13	10	Positive
15	My chemistry teacher(s) is/are highly motivating while teaching and always approachable.	3.05	12	Positive
16	My chemistry teacher uses the examples found in the environment to teach chemistry successfully.	3.02	13	Positive
14	When I am having problem in acid-base titration, I try to discuss it with the teacher.	2.98	14	Positive
17	My chemistry teacher uses instructional materials to arouse my interest while teaching some concepts in chemistry.	2.98	14	Positive
23	I develop the ability to observe, identify, report and analyze problems through the study of chemistry.	2.97	16	Positive
26	Solving problems in chemistry is my hobby, and that enhances my good performances in the subject.	2.95	17	Positive
1	Chemistry is my favorite subject.	2.88	18	Positive
5	Topics/activities in chemistry are too many.	2.85	19	Positive
13	During practical class, I finish my practical work within the time allowed for the practical period.	2.67	20	Positive

Table 1: Summary of ranks of mean attitude scores of students towards learning of Chemistry among senior school Chemistry students in North-Central Nigeria (continued)

SN	Item	Mean	Rank	Attitude of students
29	Inadequate period allocated to chemistry lesson makes the subject difficult to learn.	2.65	21	Positive
24	My parents compelled me to study chemistry.	2.53	22	Positive
4	Chemistry topics/concepts are too difficult for me to understand.	2.47	23	Negative

8	I find reading chemistry textbooks to be boring and uninteresting because the textbooks are too complex.	2.43	24	Negative
12	I hate chemistry because the syllabus is too wide which makes me find it difficult to understand when I read it.	2.36	25	Negative
22	I hate chemistry because I have to use my own initiative most of the time.	2.25	26	Negative
7	I hate chemistry because it is time consuming.	2.20	27	Negative
25	My parents told me ever before I got admission into secondary school that chemistry is a difficult and volatile subject and so I do not like it.	2.09	28	Negative
21	My chemistry teacher is too harsh.	2.04	29	Negative

Twenty-two out of twenty nine items in the Chemistry Attitude Scale ranked within the range of positive attitude towards learning Chemistry, with the mean scores ranging from 3.24 to 2.53, while the remaining seven ranked within the range of negative attitude of students toward learning Chemistry. Hence, majority of the items were ranked as positive attitude, the overall attitude of the respondents towards the learning of Chemistry could be described as positive.

Research Question 2: What is the relationship between students' attitude towards learning and their academic performance in the subject in North Central Nigeria?
The corresponding hypothesis to this question is hypothesis 1.

HO_1: There is no significant relationship between students' attitude towards learning Chemistry and their academic performance in the subject in North-Central, Nigeria.

Table 2: Chemistry students' grades in joint mock examinations conducted by states in North – Central, Nigeria in 2012

States	Grades									Total
	A1	B2	B3	C4	C5	C6	D7	E8	F9	
Kwara	4	3	5	11	28	36	50	49	214	400
Kogi	26	6	14	32	44	88	66	50	74	400
Niger	2	39	47	59	53	62	43	23	22	350
Total	32	48	66	102	125	186	159	122	310	1150

Source: State Ministries of Education.

Tables 2 and 3 show the level of Chemistry students' academic performance in the Joint Mock Examinations conducted in Kogi, Kwara and Niger States of Nigeria in 2012. The result shows that only 559 (48.61%) of the respondents from Kogi, Kwara and Niger states passed at the credit level. It could be concluded that the level of academic performance of Chemistry students was low.

Table 3: Description of chemistry students' grades in joint mock examinations in Kogi, Kwara and Niger States, Nigeria in 2012

Grade	Frequency	Percentage	Cumulative percentage
A1	32	2.8	2.8
B2	48	4.2	7.0
B3	66	5.7	12.7

C4	102	8.9	21.6
C5	125	10.9	32.4
C6	186	16.2	48.6
D7	159	13.8	62.4
E8	122	10.6	73.0
F9	310	27.0	100.0

Mean score is 49.39

Table 4: Summary of Pearson Product Moment correlation between students' attitude towards learning Chemistry and academic performance of senior school Chemistry students in North – central, Nigeria

Variables	No	Mean	Standard Deviation	df	Calculated r	p-value
Students' attitude to Chemistry	1150	81.18	11.030	1148	0.117*	0.000
Academic performance		49.39	12.480			

*: Sig. at P< 0.05

Table 4 shows that [r(1148,0.05)=0.000]. This means that there was a significant relationship between attitude and academic performance of senior secondary school Chemistry students in North-Central, Nigeria. Hence, null hypothesis was rejected. From this result, it could be concluded that attitude was a good predictor of the academic performance of senior school Chemistry students because attitude correlated positively with their performance inof Chemistry.

Summary of the Findings

The summary of the findings of the study are as follows:

(i) The overall attitude of the respondents towards the learning of Chemistry was positive.

(ii) There was a significant correlation between attitude and academic performance of senior secondary school Chemistry students in North-Central, Nigeria.

Discussion

The significant relationship established between attitude and academic performance of senior secondary school Chemistry students in North-Central, Nigeria is an indication that students' attitude to learn Chemistry could be a predictor of what their performance will be in Chemistry examinations. This finding is similar to that of Papanastasiou (2001) who reported that individuals who had positive attitude towards science subjects tend to perform better in the subject because their affective behaviours are strongly related to performance.

Also, this finding is also in agreement with that of Escalona (2005) who determined the correlation between attitude toward Chemistry and Chemistry performance of second year regular students enrolled in Chemistry at John B. Lacson Colleges Foundation in Bacolod. The result showed a positive and significant relationship between the students' attitude towards Chemistry and their performance in the subject.

The finding is also in agreement with that of Oyedokun (2005) who found a significant relationship between students' attitude and school academic performance in Biology. Furthermore, findings of the present study agree with those of Oluwatelure and Oloruntegbe (2010) who examined the attitude of students towards Biology and Chemistry. Their results revealed that performance of students in science, particularly Chemistry, were partly a function of their attitudes to the subject.

This finding however contradicts that of Ma and Kishor (1997) in which no significant relationship was clearly established between students' attitudes and their academic performance Mathematics. For most of the related studies available in the literature however, more studies seemed to have established significant relationship between students' attitudes and academic performance than otherwise.

Conclusion

The major conclusion from this study is that the attitude of Chemistry students in North-Central Nigeria towards the learning of Chemistry was positive, and this could serve as one of the predictors of their performance in Chemistry.

Recommendations

Based on the results of the findings in this study, the following recommendations are advanced:

(i) Chemistry teachers should device appropriate instructional methods that would sustain and even improve the attitude of the students towards the learning of Chemistry, as a way of improving their performance in the subject.

(ii) Teachers should endeavour to always emphasise the importance of Chemistry knowledge to their students as a way of motivating better attitudes towards the subject.

(iii) Adequate facilities for teaching Chemistry should be provided in schools so as to prevent students from developing negative attitudes towards the subject, as this will lower their performance in the subject.

(iv) Parents should provide their wards with necessary incentives (e.g. modern textbooks) that would enhance the sustenance of positive attitude towards the subject.

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PERCEIVED USEFULNESS OF INFORMATION AND COMMUNICATION TECHNOLOGIES AMONG COLLEGE OF EDUCATION LECTURERS IN NIGERIA

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Abstract

*The influence of availability and attitude on the use of Information and Communication Technology has been extensively studied. However, little or no attention is given to the usefulness of ICT among College of Education Lecturers. This study investigated perceived usefulness of information and communication technologies among college of education lecturer in Nigeria. In this study, three research questions were raised to understand the lecturers' perception of application, proficiency in usage and the influence of teachers' age, educational qualification, gender, ICT training, teaching experience and ICT usage skills. The study adopted a descriptive survey research type. The population of the study consisted of college of education lecturers in south west, Nigeria. 200 lecturers were randomly sampled from the randomly selected five Colleges of Education in South West, Nigeria. The instrument for data collection was a 30 items self developed likert scale questionnaires, where respondents were asked to rate their perception of the application of ICT, proficiency level in the usage of ICT software packages in teaching and the relationship of teachers' age, educational qualification, teaching experience, gender, ICT training and ICT usage skill. The instrument titled: "*CLICTAP*" was validated by experts opinion. A Cronbach Coefficient Alpha was used to obtain the reliability coefficient value of 0.75. Percentage counts and Pearson's product moment correlation (PPMC) statistical methods were used to analyze the data collected. The result on perceived usefulness of ICT revealed that majority of respondents agreed that ICT can improve teaching and learning process. The result also revealed that most lecturers are highly proficient only in the use of word processing, e-mail and search engines, but are lowly proficient in other software packages e.g. statistical and graphic. The result of the correlation matrix showed significant relationship among teachers' gender ($r = 0.278$, $P< 0.05$), educational qualification ($r = 0.261$, $P < 0.05$) teaching experience ($r = 0.129$, $P< 0.05$) and training on ICT ($r = 0.461$, $P < 0.05$) and ICT usage skill. Based on the findings of this study, it was recommended that more training and capacity building on ICT should be provided by the management of the institutions and support should be provided by the government and other relevant agencies to equip the staff of these institutions with the needed ICT equipment in other to improve their application and usage proficiency level.*

Keywords: Information Technologies, Perception of Application. Proficiency, Management, National Policy on Education

Introduction

Information and Communication Technology (ICT) has become essential tool in man's daily lives and educational system. The Federal Government of Nigeria (2013) is very clear in the National Policy on Education which stipulates that the goal of education is the development of

appropriate skills, mental, physical and social abilities and competencies to empower the individual to live in and contribute positively to the society. To this end, there is a growing demand on educational institutions to use ICT in teaching the skills and knowledge students need for the 21st century (Okoli, 2005). Realizing the effect of ICT on the workplace and everyday life, today's educational institutions try to restructure their educational curricula and classroom facilities in order to bridge the existing technology gap in teaching and learning. This restructuring process requires effective adoption of technologies into existing environment in order to provide learners with knowledge of specific subject areas, to promote meaningful learning and to enhance professional productivity (Tomei, 2005). In fact, some universities in Nigeria are placing technology competency requirement upon teachers and their graduates (Olori, 2008). The inclusion of ICT in our education and the National Policy on Education is highly necessary as we target the millennium development goals of 2015.

In spite of the fact that it is government policy that teaching shall be practical, activity-based, and experimental and IT supported, the integration and adoption of technology into instruction is one of the challenges confronting university and colleges of education lecturers in Nigeria. Okebukola (1995) and Ololube (2006) added that this view is reinforced by several recent studies of the faculty use of ICT in instruction, which indicate that many lecturers do not use it in any systematic or curricular way. It is believed that if teachers perceived technology application as neither fulfilling their needs nor their students' needs, it is likely that they will not integrate the technology into their teaching and learning (Czerniewicz & Brown 2005; Payal & Monika, 2007). Donna (2000) opined that requiring a set of skills or technology competencies for college lecturers do not insure technology will be used in the classroom or that it will be effectively applied. Implementing technology competencies policy may be a catalyst, but effective use of it in the classroom will require adequate information on perception of application, training for proficiency and technical support by the management of the institution (Umunadi, 2012). The International Society for Technology in Education (ISTE), a professional education organization, and the CEO Forum, a think tank comprised of education leaders in Washington D.C are responsible for recommending guidelines for accreditation to the National Council for Accreditation of Teacher Education (NCATE). The CEO Forum has recommended that teachers' competency in the use of technology is a mandatory component of licensure by 2002 (CEO Forum, 1999). According to the Forum, teachers in the United States are undertrained on using the instructional technologies available to them. The Forum estimates that schools spend roughly $88 per student on computer equipment, but only $6 per student on training teachers to use the technology. Many teachers are unable to integrate the technology into their lessons because of lack of perceived usefulness of application and lack of proficiency skill. The Forum observed that only 20% of teachers were comfortable using computer technology in the classroom. Recognising the significant of technology in education, Mishra and Koehler (2006; 2008) introduced a conceptual framework on TPACK by adding the technological knowledge elements to the Shulman (1987) Pedagogical content knowledge (PCK) framework. Mishra and Koehler (2006) argued that teachers need to develop technological pedagogical content knowledge (TPACK) in order to be successful users of technology in their teaching. Adebanjo (2010) observed that despite all the benefits associated with ICT, in Nigerian tertiary institutions, there is lack of adequate and suitable ICT equipment, and this has greatly affected lecturers' productivity.

How does this affect higher education? Teacher educators' perception, their use of, and attitude towards educational technology can have significant impact on pre-service and in-service teachers' implementation of technology in the classroom. Since teacher training institutions are

saddled with the responsibility of producing technology competent teachers, that competencies have to be placed on the instructors who are themselves not just able to apply the technologies, but also proficient (Donna,2000). The question remains whether a University Faculty of Education or College of Education can expect teacher trainers not to possess the same technology skill required of its graduates? Since education requires inputs from the fast changing information technology environment, it becomes imperative for teacher trainers to use information technology tools such as internet-mail, e-library, interactive video, interactive board, Mp3, power point, multimedia, computer games and blended learning to enhance learning outcomes. The planning of learning activities will be easier, less time consuming and expanded in scope with the availability of instructional technologies and their skills in drawing from it will improve their teaching ability (Ololube, 2006). The decisions made by the teachers about the use of information and communication technologies in the classroom is likely to be influenced by multiple factors such as age, educational background, accessibility to ICT resources, experience in use of instructional technology, training, consultation, mentoring, technical support, reward and recognition for following the desired behaviour, attitude, gender, ability, perception about usefulness, perception of application, proficiency level, creativity in the faculty members and the students, number of years of existence of the institute and ease of use (Samuel & Bakar, 2006).

With the present day computerization of activities in education, the focus is now on application of ICT in schools at all levels (Folayan & Ibrahim, 2000). Ekweremadu (2001) stated that when computer is properly integrated and applied into educational programme, it would help to improve the academic training for science and technology education and holds out the opportunity to revolutionize pedagogical methods and expand access to quality education. There is need to brace up to the new challenges and systems of education through the development and application of instructional technologies in colleges of education. Okoli (2005) noted that in order to use technology in the classroom effectively, teachers' perception on application should be positive and should be trained in using the modern technologies in the field of education. Recent studies indicate that teachers' perception on the application of information technology have significant implications for their behaviours in its use for teaching (Charles Buabeng-Andoh, 2012). For successful adoption and integration of ICT into teaching, teachers must perceive the application of technology as better than previous practice, consistent with their existing values, past experiences and needs. (Donna, 2000).

The three levels of information technology application are: (a) personal productivity aids, (b) enrichment add-ins, and (c) paradigm shift (Massy & Zemsky, 1995). Personal productivity aids are applications that allow teachers to effectively use word processing and spreadsheets for instruction. Enrichment add-ins allows teachers to inject video, e-mail, listservs, web pages, power point, multimedia and simulation. The paradigm shift is where faculty members and their institutions reconfigure teaching and learning activities to take full advantage of new technologies. Many teachers are hesitant to change an existing programme to something they only know through discussion and reading and not through observation. The key factor in the studies is teachers' perception towards application of technology or intentions to use technology in their classrooms. If teachers have negative perception toward technology, providing them with excellent ICT facilities may not influence them to use it in their teaching (Ololube, 2006). Therefore, teachers need to be assured that technology can make their teaching interesting, easier, more fun for them and students, more motivating and more enjoyable.

Several studies have been conducted on factors that influence teachers' proficiency in the use of ICT in the classroom. Balanskat, Blamire, and European Schoolnet (2007), categorized the factors that influence teachers' ICT use as teacher level, school-level and system-level barriers. Teacher-level barriers include lack of teacher ICT skills; lack of teacher confidence; lack of pedagogical teacher training; lack of follow-up and lack of differentiated training programmes. The school-level barriers comprise absence of ICT infrastructure; old or poorly maintained hardware; lack of suitable educational software; limited access to ICT; limited project-related experience; lack of ICT mainstreaming into school's strategy and the system-level barriers include rigid structure of traditional education systems; traditional assessment; restrictive curricula and restricted organizational structure. Yildirim (2007) conducted a survey and reported that the major use of technology by teachers was to prepare lesson notes and assessments instead of improving students' performances. The research revealed that barriers to teachers' proficiency in the use of technology include congested classes, insufficient training, teachers' age, qualification, teaching experience, gender, inadequate technical and pedagogical support, rigid school syllabi, inadequate motivation, lack of strong leadership and inadequate cooperation among teachers. Okoli (2005) viewed that teachers' age has no relationship with the extent to which they utilise ICT in the school. Slaouti and Barton (2007) also claimed that lack of access, time pressures, lack of mentors and opportunities for training have effect on teachers' proficiency in the use of ICT in teaching and learning. Likewise, Peralta and Costa (2007) collected and analyzed data on teachers' confidence and proficiency in the use of ICT in teaching. The quantitative and qualitative research randomly sampled 20 teachers from Greece, Italy, Spain, Portugal and the Netherlands. The findings revealed that lack of teachers' time to learn new skills, old ICT equipment, large classes, number of computers available for pupils' use, lack of technical and pedagogical support and lack of collaboration among teachers were constraints to teachers' confidence and proficiency in the use of ICT. Understanding the extent to which these barriers affect tertiary institutions in Nigeria may help in deciding how they can be tackled.

This study seeks to investigate the perception of Nigerian College of Education Lecturers towards the usage of information and communication technology (ICT) in teaching and learning. It determines to find out proficient level of the college lecturers in the usage of ICT as a better mode of teaching. This study will determine the lecturer's perceptions of the application of ICT in teaching. It will identify the ICT skills that could be used in enhancing lecturers' performance. The result of the study will help the government and managements of the various colleges of education to be more proactive in implementing information technology policy as stipulated in the National Policy on Education.

Statement of the Problem

Despite the global understanding that ICT usage is an essential skill for 21st century teachers, it is worrisome that tertiary institutions in Nigeria mainly use it for administrative purposes such as pay roll, inventories, order forms and attendance records. In these institutions, lecturers may not be provided with adequate facilities that will make them to adopt and integrate ICT in their instruction. This barrier is likely to have significant influence on the staffs' perception and proficiency level. Therefore, there is need to investigate the perceived usefulness of information and communication technologies among college of education lecturers in Nigeria.

Research Questions

The following research questions were generated and tested:

(i) What are the lecturers' perceptions of the application of ICT in teaching?
(ii) What are the lecturers' proficiency levels in the usage of ICT software packages in teaching?
(iii) Is there significant relationship between lecturers' gender, age, educational qualification, teaching experience, ICT training and ICT usage skills?

Methodology

This study adopted descriptive survey research design type to study the College of Education lecturers' ICT application and proficiency level. All the College of Education lecturers in Southwest part of Nigeria constitute the population for the study. Multistage sampling method was used. Proportional sampling method was used to select 3 (50%) out of the 6 states in southwest, Nigeria. The sample for the study comprised of 200 lecturers that were randomly sampled from five Colleges of Education in three (3) states in Southwest, Nigeria. Forty (40) lecturers were randomly selected from each college of education. The instrument used for the study was a self developed 30 items questionnaire titled" College lecturers' ICT application and usage proficiency "(CLICTAP). Section A covered teachers' bio-data such as age, qualification, teaching experience, gender and ICT training. Section B is a 3 section likert- type option, where lecturers were asked to rate their perception of application of ICT in teaching, proficiency in the use of software packages and the ICT usage skill.

The instrument was subjected to face and content validity by experts in educational technology and educational evaluators, after which it was found to be above 85% in agreement with experts' opinion. The instrument was trial tested on 30 lecturers who were not part of the main study and Cronbach Coefficient Alpha was used to obtain the reliability coefficient value of 0.75.The five colleges of education involved in this study were visited by the researcher and upon being granted permission by the management, administered the instrument. These institutions were visited in different days and with the help of a research assistant, all the questionnaires administered were completed and returned to the researcher. The data obtained were analysed with Percentages Counts and Pearson Product Moment Correlation (PPMC).

Results

Research Question 1: What are the lecturers' perceptions on ICT application in teaching?

Table I: Percentage distribution of lecturers' perception on ICT application in teaching

S/N	Variables	SA(%)	A (%)	D (%)	SD (%)
1	ICT can improve teaching and learning process.	82.00	18.00	0.0	0.0
2.	ICT can enhance students' critical thinking skill.	66.00	34.00	0.0	0.0
3.	ICT can enhance students participation	56.00	42.00	0.0	2.0
4.	ICT can enhance collaboration among students.	42.00	56.00	2.0	0.0

5.	ICT can enhance lecturers and students interaction.	52.00	46.00	2.0	0.0
6.	Internet application can provide access to educational resources	69.00	31.00	0.0	0.0
7.	ICT tends to increase students' learning motivation.	42.00	55.00	3.0	0.0
8.	ICT can enhance students' language writing skill	29.00	54.00	16.0	0.0
9.	ICT application will encourage teachers' creativity	53.00	47.00	0.0	0.0
10.	ICT application will enhance effective teachers' communication	62.00	38.00	0.0	0.0

*Figure within parentheses are presented in percentages

The lecturer's perception on the application of ICT as shown in the table 1 below revealed that majority of the respondents i.e 82% strongly agreed that ICT can improve teaching and learning process, 66% strongly agreed that ICT can enhance students' critical thinking skill, 56 % strongly agreed that ICT can enhance students participation, 69% strongly agreed that internet application can provide access to educational resources, 53% strongly agreed that ICT application will encourage teachers' creativity and 62% strongly agreed that ICT application will enhance effective teachers' communication, Also, majority of the respondents i.e 56% agreed that ICT can enhance collaboration among students, 55% agreed that ICT tends to increase students' motivation to learn and 54% agreed that ICT can enhance students' language writing skill.

Research Question 2: What are the lecturers' proficiency levels in the usage of ICT software packages in teaching?

Table 2: Percentage Distribution of Respondents According to Proficiency level in the Usage of ICT Software Packages

S/N	Software Packages	Very High Proficiency	High Profiiency	Moderate Proficiency	Low Proficiency	No Proficiency
1	Word processing	44 (22.0%)	62 (31.0%)	78 (39.0%)	16(8.0%)	(0.0%)
2	Spreadsheet	40 (20.0%)	24 (12.0%)	72 (36.0%)	50(25.0%)	14 (7.0%)
3	PowerPoint	28 (14.4%)	58 (29.9%)	70 (36.1%)	30 (15.5%)	4(4.10%)
4	Data Base	18 (9.30%)	48 (24.7%)	80(41.2%)	36 (18.6%)	12 (6.2%)
5	Search engine	62 (31.0%)	72 (36.0%)	38 (19.0%)	24 (12.0%)	4 (2.0%)
6	E- mail	76 (38.0%)	86 (43.0%)	18 (9.0%)	20 (10.0%)	(0.0%)
7	Graphic software	14 (7.0%)	20 (10.0%)	60 (30.0%)	50 (25.0%)	56 (28.0%)
8	Encyclopaedia	26 (13.0%)	50 (25.0%)	68 (34.0%)	28(14.0)%	28 (14.0%)
9	Multimedia Package	28 (14.0%)	42 (21.0%)	72 (36.0%)	26 (13.0%)	16 (1 32 (16.0%)
10	Statistical package	20 (10.0%)	32 (16.0%)	72 (36.0%)	48 (24,0%)	14 (28 (14.0%)

*Figure within parentheses are presented in percentages

The result of the findings in table 2 revealed that 22% of the respondents are very highly proficient in the use of word processing, 20% are very highly proficient in the use of spreadsheet, 14% are very highly proficient in the use of power point, 9% are very highly proficient in the use of database, 31% are very highly proficient in the use of search engine, 38% are very highly proficient in the use of e-mail, 7% are very highly proficient in the use of graphic software, 13% are very highly proficient in the use of encyclopaedia, 14% are very highly proficient in the use of multimedia packages and 10% are very highly proficient in the use of statistical packages.

Research Question 3: Is there a significant relationship among lecturers' gender, age, educational qualification, teaching experience, ICT training and ICT usage skills?

Table 3: Summary of correlation matrix in the relationship among the variables

Variables	Mean	SD	1	2	3	4	5	6
Gender	34.42	15.3			1.00			
Age	32.12	11.5			-1.01	1.00		
Educational qualification	29.13	16.2				0.135	1.00	
Teaching experience	42.16	14.4			-0.110		0.128	1.00
Training on ICT	36.24	17.9		0.048	0.106	-0.022		
ICT usage skill	38.124	18.9	0.278*	0.049	0.261*	0.129*	0.461*	

*: Significant (P< 0.05)

The results of the correlation matrix of ICT usage and independents variables in table 3 revealed that gender(r= 0.278,P < 0.05),educational qualification(r= 0.261,P < 0.05)teaching experience(r= 0.129,P < 0.05) and training on ICT(r=0.461,P < 0.05)do significantly influence ICT usage skill.

Discussion

The result of table 1 showed that lecturers' perception of the application of ICT in their teaching and learning activities was positive. This was corroborated with the views of Okoli (2005) and Charles (2012) that for successful adoption and integration of ICT into teaching, teachers must perceive the application of technology as better than previous practice, consistent with their existing values, past experiences and needs, ease to use and can be experimented with.

The result of table 2 revealed that college lecturers' proficiency level in the use of the ICT software is still relatively low. This result is in agreement with Yildirim (2007); Slaouti and Barton (2007) who found teachers to be more proficient in the use of e-mail and word processing than other applications. Evidence revealed that teachers' mastery of ICT skills is critical in its successful integration to teaching (Peralta & Costa, 2007).The study also showed that integration of ICT into lecturing helps teachers to search for information and find instructional resources. This finding is consistent with the findings of Stavropoulos and Moschona (2007) that word processing software, CD-ROM reference software, and World Wide Web browsing software were the most commonly used applications by teachers regardless of the subject they teach.

The result of correlation matrix in table 3 revealed that that gender, educational qualification, teaching experience and training have significant influence on the usage of Information Communication and Technology in teaching. Olori (2007) and Charles Buabeng-Andoh (2012) study supported the result of this finding that teachers' gender, teaching experience, teachers qualification have significant influence on the use of ICT in teaching. However, the relationship between ICT usage and age of the respondents was not significantly correlated. This result corroborated the view of Okoli (2005) that teachers' age has no significant influence on ICT skill.

Conclusion

The study has helped to reveal the level of usage of information communication and technology in teaching by the college of education lecturers. It shows that majority of the lecturers were moderately proficient in the use of word processing and the hardware use was mainly the computer. The respondents exhibited a positive response to the application of ICT in teaching. The correlation matrix also showed that there is a significant relationship between usage of ICT viz -a- viz: gender, educational qualification, teaching experience and training on information communication and technology.

Recommendations

Based on the results of the study, the following far reaching recommendations were made:

(i) The management of the colleges of education should provide regular in-service training for lecturers on educational technology skills.

(ii) Adequate technological resources, technical support and administrative support should be provided to enable them successfully use information communication and technology (ICT) in the classroom.

(iii) Incentives should be provided to the lecturers to acquire some ICT hardware that will enhance their teaching and learning.

(iv) Regular capacity building workshop should be organized by the College Management to keep the lecturers abreast of the latest development in the information communication and technology (ICT) world.

(v) The licence conditions for teaching professionals should include competency test on instructional technology.

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PROBLEMS OF STUDENTS' AVERSION TO LEARNING BASIC TECHNOLOGY: A STUDY OF JUNIOR SECONDARY SCHOOLS IN MARYLAND METROPOLIS, LAGOS STATE

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Abstract
The study identified problems of students' aversion to learning Basic technology in Junior secondary schools in Maryland Metropolis, Lagos State. Two research questions and two hypotheses were used for the study. A structured questionnaire was used for data collection from one hundred and fifty eight respondents. The data were analyzed using mean and standard deviation. T-test statistics was used to test hypotheses at 0.05 level of significance. Cronbach Alpha formula was applied to determine the reliability coefficient of the instrument and it was found to be 0.86. The instrument was subjected to face and content validation by three experts from the Department of Science and Technology Education of University of Lagos. The study revealed among others lack of teaching facilities, students' participation in practical work and teaching methods adopted by teachers were the causes of students' aversion to learning Basic technology. It is recommended that teachers and students should participate in practical exercise and application of ICT for teaching Basic technology is essential to arouse students' interest in the subject.

Keywords: Aversion, Basic Technology, Facility, Junior Secondary School, Learning, Teaching

Introduction
Basic technology is an appropriate subject for all children in junior secondary school because of its importance to national development. Alhassan (2000) identified two broad aims of Basic technology at the secondary school level. This includes given children awareness on technology and as a tool for developing practical capability of students to engage in technological activities. National Policy on Education (Federal Republic of Nigeria, 2004) stipulates that efforts should be made to inculcate attitude that would make the students appreciate the role of technology in the society. Students often find it difficult to learn Basic technology despite government's effort towards revamping vocational subjects at the Junior Secondary School level by providing equipment and employing Basic technology teachers. The problem of students' aversion to learning Basic technology often threatens the development of prospective engineers and technologists and other technology related profession. Students' aversion to learning Basic technology can be explained as lack of students' interest in Basic technology. Students' aversion to learning Basic technology, according to Eze-Okeke (1998), could be due to the fact that, technology and science involve a lot of Mathematics which students often find difficult. Similarly, a lot of practical class and workshop practical activity and the curriculum content is loaded with so many trades to cover. Akinmoyewa (2000) revealed that understanding of the nature, interest and the need of the students, adequate knowledge of the subject matter, the use of relevant and effective instructional materials and the ability to communicate, control and

manage the class are important in making the student to learn effectively. Students' aversion can be controlled by ensuring that necessary measures are taken so that teaching and learning of Basic technology at junior secondary school would be interesting.

Students' aversion to learning Basic technology is seen directly in their attitude and interest towards the subject by not performing well and many of them fail to choose technical subjects or trades as they proceed to senior secondary school. Onwuchekwa (2001) pointed out that the negative attitude and interest of students towards technology subject in Secondary Schools is a serious concern to educators and parents. According to Onwuchekwa, more students opted for art or commercial subjects while few settled for technology subjects. The rate of decline in students' enrolment in technology related subjects in West African Examination Council (WAEC) and National Examination Council (NECO) examination is so alarming. This might be as a result of students' aversion to learning Basic technology at Junior Secondary School level. When students are not well taught, they loose interest and hence, leads to strong aversion for the subject. At entry level into Secondary Schools, many students have decided not to offer technology related subject. The negative attitude and interest of students towards the subject have significantly affected the development of science and technology in the country. The few students who show interest in Basic technology do not perform well in the subject.

Agogo (2002) revealed the poor performance of students in science and science-based subjects of which Basic technology is one. Junior Secondary School examinations are pointers to the fact that students develop negative attitude to the subject. Agogo stressed further that students encounter difficulties in learning Basic technology because of cultural differences. Onwuchekwa (2001) stressed that the reason for aversion could be problems generated by the student themselves and the poor attitude of government and society towards technology. The federal government and state government have tried in providing laboratories, workshops, audio-visual aids among others for teaching Basic technology. Though, these laboratories and workshops may not be adequate. Government has also tried to boost interest in Basic technology by formulating certain policies. For instance, the 60-40 admission policy into higher institutions in favour of the science and technology oriented students. (Eze-Okeke, 1998). In spite of all these effort by the government, there are large number of students that still exhibit aversion to learning Basic technology.

Statement of the Problem

Basic technology is that aspect of education that exposes learners to technology trades and basic scientific knowledge. They learners are expected to acquire practical skills towards self reliance. Basic technology is a subject offered at Junior secondary schools and it aims at developing students technological skills that can transform Nigeria into industrialized nation. A nation can't achieve any meaningful technological development except she is able to harness the natural resources within her domain. The problems of aversion towards learning Basic technology place limitation on the level students can attain academically. In order words, students' aversion to learning Basic technology results to lost of concentration by students and failure in promotional or external examination or continuous assessment. The effects of this, is that it can affect technological development in Nigeria.

Purpose of the Study

The study examined the problems of students' aversion to learning Basic technology in Maryland metropolis of Lagos State. Basically, the study sought to:

(i) Find out problems of students' aversion to learning Basic technology in Maryland metropolis of Lagos State.
(ii) Identify strategies for enhancing students' interest in learning Basic technology in Maryland metropolis of Lagos State.

Research Questions

The following research questions posed guide the study

(i) What are the problems of students' aversion to learning Basic technology in Maryland metropolis of Lagos State?
(ii) What are the strategies for enhancing students' interest in learning Basic technology in Maryland metropolis of Lagos State?

Hypotheses

The following hypotheses were tested for the study:

Ho_1: There is no significant difference between mean rating of male and female students on the problems of students' aversion to learning Basic technology.
Ho_2: There is no significant difference between mean rating of male and female students on the strategies for enhancing students' interest in learning Basic technology.

Research Methodology

Survey research design was used to carry out this study. Survey research design deals with the gathering of data and describing it in a systematic manner, the characteristic, features and facts about a given population (Nworgu, 1991). The population for this study comprised of year three Basic technology students in Junior secondary schools in Maryland Metropolis, Lagos State. These students have been exposed to Basic technology as a subject right from year one in the Junior secondary school.

There were eight junior secondary schools in Maryland Metropolis offering Basic technology and five of them were used for the study. The five Junior secondary schools used include Mende Junior High School, Maryland, Lago; Immaculate Heart Comprehensive Junior High School, Maryland, Lagos; Command Day Secondary School, Maryland, Lagos; Redeemer's International Secondary School Maryland, Lagos and Maryland Comprehensive Secondary School, Maryland Lagos.

Simple random sampling technique was used to select 162 students for the study. The school differ from each other in terms of population and for fair judgment in terms representation based on population, twenty per cent (20%) of year three students in each school was sampled from 810 students. Each student was given equal chance of being included in the sample. The use of slips of paper with identification mark was adopted. Students who picked the slips of paper with the identification mark were included in the sample. A total of one hundred and sixty two students were selected from the five Junior secondary schools. The method (slip of paper with identification mark) was applied for selection of schools for the study. Structured questionnaire was used to elicit information from the respondents. Structured questionnaire is the type of questionnaire that restricts the respondent to the response options provided for them. The questionnaire is in two sections; section A focused on the problems of students' aversion to learning Basic technology while section B solicited for information from respondents on the strategies for effective learning of Basic technology to enhance students' interest. The instrument was subjected to face and content validatation by three technology education

experts of Department of Technology Education, University of Lagos, Akoka, Lagos. The reliability coefficient of the instrument was determined using Cronbach Alpha formula. The reliability coefficient of the instrument was found to be 0.86. The researchers and a research assistant visited the schools used for the study and administered the questionnaire to the students of Basic Technology in JSS3. The questionnaire was retrieved immediately after completion by the respondents. Out of one hundred and sixty two (162) questionnaire given out, one hundred and fifty eight (158) were retrieved i.e., 97.53% return rate.

Mean and standard deviation were used to analyze research questions while t-test statistics was used to test the null hypotheses formulated. Four points rating scale was used which are Strongly Agree (SA) 4points, Agree (A) 3 points, Disagree (D) 2 points and Strongly Disagree (S.D) 1 point. Items having 2.50 and above were accepted while those items having below 2.50 were rejected.

Results

Research Question 1: What are the problems of students' aversion to learning Basic technology in Maryland metropolis, Lagos State?

Table 1: Mean rating and standard deviation of respondents on problems of students' aversion to learning Basic technology in Maryland metropolis, Lagos state
N = 158

S/N	Item statement	$\bar{X}$	SD	Decision
1.	Students developed apathy towards Basic technology because of lack of teaching facilities in the workshop.	2.14	1.02	Reject
2.	Students lack interest in Basic technology due to lack of practical work.	2.69	1.07	Accept
3.	Students hate Basic technology because teachers do not use instructional materials when teaching.	2.53	1.13	Accept
4.	Students don't like Basic technology because it seems not relevant to their immediate environment.	2.53	1.13	Accept
5.	Students do not have interest in Basic Technology because of the teaching method adopted by teachers.	2.06	0.97	Reject
6.	Students do not choose career in technology because Basic technology courses are task demanding.	2.49	1.68	Reject
7.	Students lack interest in Basic technology because it is only the teachers that perform experiment in the workshop due to limited materials to work with.	2.62	1.71	Accept

Table 1 shows that respondents agreed with Items 2, 3, 4 and 7 based on the decision that their mean ratings were greater than the cut off point of 2.50 and disagreed with item 1,5 and 6. This means lack of teaching facilities in the workshop, teaching methods adopted by teachers and technology courses are task demanding didn't contribute to students' aversion to learning of Basic technology. The standard deviation revealed that there is closeness in the opinion of the respondents.

Research Question 2

What are the strategies for enhancing students' interest in learning Basic technology in Maryland metropolis, Lagos State?

Table 2: Mean rating and standard deviation of respondents on strategies for enhancing students' interest in learning Basic technology in Maryland metropolis, Lagos State

N = 158

S/N	Item statement	$\bar{X}$	SD	Decision
8.	Teacher ensured that students participate in practical work in the workshop.	3.07	0.89	Accept
9.	Encouraging to learn Basic technology by making the content taught relevant to their immediate environment.	3.06	0.81	Accept
10.	Involving students in excursion to industries to see what they have learnt in the class.	2.63	1.04	Accept
11.	Teachers of Basic technology used instructional material for teaching.	3.09	0.93	Accept
12.	Students are encouraged to express their acquired technical skill in the technology workshop.	2.90	1.04	Accept
13.	Teaching of Basic technology can be enhanced with the application of ICT for teaching to arouse students' interest in the subject.	3.28	0.80	Accept
14.	Making Basic technology a core subject required for promotion of students to the next class can develop positive attitude towards the subject.	2.73	1.08	Accept

Table 2 reveals that respondents agreed with all the items. Therefore, students' interest will be enhanced if the above strategies are adopted by Basic technology teachers when teaching Basic technology. The standard deviation disclosed that there is closeness in the opinion of the respondents.

Hypotheses

H_{01}: There is no significant difference between the mean rating of male and female students on the problem of students' aversion to learning Basic technology.

Table 3: Summary of t-test of respondents on the problems of students' aversion to learning Basic technology

S/N	Item statement	$\bar{X}_M$	SD_M	$\bar{X}_F$	SD_F	t_{cal}	t-value	Remark

1	Students developed apathy towards Basic technology because of lack of teaching facilities in the workshop.	2.82	0.97	2.69	1.05	0.62	1.64	Not Significant
2	Students lack interest in Basic technology due to lack of practical work.	2.74	1.09	2.66	1.06	0.39		Significant
3	Students hate Basic technology because teachers do not use instructional materials when teaching.	2.33	0.92	2.39	1.14	0.27		Not significant
4	Students don't like Basic technology because it seems not relevant to their immediate environment.	2.49	1.16	2.59	1.11	0.63		Not Significant
5	Students do not have interest in Basic technology because of the teaching methods adopted by teachers.	1.90	0.82	2.16	1.05	0.01		Not significant
6	Students do not choose career in technology because Basic technology courses are task demanding.	2.49	1.18	2.49	1.16	0.82		Not Significant
7	Students lack interest in Basic technology because it is only the teachers that perform experiment in the workshop due to limited materials to work with.	2.49	1.02	2.70	1.10	0.55		Not Significant

Key:
$\bar{X}_M$ = Mean for the males
SD_M = Standard deviation for the male
$\bar{X}_F$ = Mean for the female
SDF = Standard deviation for the female
t_{cal} = 1.64, level of significant = $p<0.05$, df = 156

The data in table 3 shows that the t-calculated for all the items were less than the t-table value ($p<0.05$) which means there is no significant difference. Therefore, the null hypothesis was accepted.

Table 4: Summary of t-test analysis of respondents on strategies for enhancing students' interest in learning Basic technology

S/N	Item statement	$\bar{X}_M$	SD_M	$\bar{X}_F$	SD_F	t_{cal}	t-value	Remark
8	Teachers ensured that students participate in practical work in the workshop.	3.14	0.93	3.02	0.84	0.76	1.64	Not Significant
9	Encouraging students to learn Basic technology by making the	3.23	0.87	2.95	0.76	1.69		Not Significant

	content taught relevant to their immediate environment.						
10	Involving students in excursion to industries to see what they have learnt in the class to enhance their interest in Basic technology.	2.41	1.04	2.77	1.02	-1.70	Not Significant
11	Teachers of Basic technology used instructional material for teaching.	3.21	0.86	3.02	0.97	0.98	Not Significant
12	Students are encouraged to express their acquired technical skill in the technology workshop.	2.92	1.17	2.89	0.96	0.17	Not Significant
13	Teaching of Basic Technology can be enhanced with the application of ICT for teaching to arouse students' interest in the subject.	3.38	0.74	3.21	0.83	1.04	Not Significant
14	Making Basic technology a core subject required for promotion of students to the next class can develop positive attitude towards the subject.	2.74	1.04	2.72	1.11	0.10	Not Significant

Key:
$\bar{X}_M$ = Mean for the males
SD_M = Standard deviation for the male
$\bar{X}_F$ = Mean for the female
SDF = Standard deviation for the female
t_{cal} = 1.64, level of significant = $p<0.05$, df = 156

In table 4, the result reveals that the t-calculated for item number 8,10,11,12,13 and 14 were less than t-table value ($p<0.05$) which disclosed that there is no significant difference. The null hypothesis was accepted while t-calculated for item number 9 was more than the t-table value ($p<0.05$) which means that there is significant difference. The null hypothesis was rejected. This proves that there is significant difference between the mean rating of male and female students with reference to encouraging students to learn Basic technology by making the content taught relevant to their immediate environment.

Discussion

The study revealed that lack of teaching facilities and qualified teachers is one of the causes of students' aversion to learning Basic technology. Alhassan (2000) observed that aversion to learning is often revealed in poor students academic performance in schools which some times is as a result of lack of adequate equipment, qualified teachers to teach the subject, maintenance of the equipment and facilities used for workshop practice and the bureaucrats in education. Ukpongson (2000) postulated that the problem of qualified teachers appear to be so grave perhaps hinging on the fact that no educational system can rise above the caliber of its teacher or educational policy, no matter how well planned, educational system can't succeed without the supply of the right quality and quantity of teachers. The acquisition of adequate tools and equipment and the provision of adequate workshop space in the absence of adequate supply of qualified teachers amount to failure and often discourage the students to learn what they are expected to know. In a situation where an integrated science teacher is teaching Basic

technology without the training as a technical teacher will lead to problems in making sure students do not acquire the right skills needed for the right job to perform a particular task in Basic techology (Onwuchekwa, 2001).

The study discovered that making the content relevant to the immediate environment of the student will enhance their interest in Basic technology. Okorie (2001) disclosed that students should be exposed to occupational opportunities available to them which include machining, radio and television services, automobile, body repair work, refrigeration and air conditioning, Bakery, carpentry, cabinet making, welding, painting etc. It was revealed in the study that teachers should ensure that students participate in the practical work in the workshop. Onwuchekwa (2001) emphasized that Basic technology is a practical oriented subject, therefore, it needs the participation of both the teacher and students in the practical. Students' active participation in practical work will enhance their development of positive attitude towards the subject.

Conclusion

The level of students' aversion to learning Basic technology cannot be left unchecked so all hands must be on desk to ensure that students' interest is maximally enhanced in learning Basic technology. Students find it hard to perform well as a result of lack of teaching equipment and teaching methods adopted by Basic technology teachers. Application of ICT for teaching and learning Basic technology is very essential to enhance students understanding of the subject and also to arouse their interest which many schools are lacking. Students should be encouraged to develop interest in Basic technology since no country will develop technologically when technical knowledge and skills are lacking. Therefore, Basic technology teachers should strive harder to make sure those things causing students' aversion to learning Basic technology are minimized or solved.

Recommendations

The following recommendations are made:

(i) Teachers of Basic technology should ensure that instructional materials are often used to enhancing understanding of the subject and also to arouse students' interest in Basic technology.

(ii) Students should be allowed to carry out practical exercise at least once in a week so that their skills can be developed which can also influence their attitude towards the subject.

(iii) Adequate fund should be provided for procurement of materials and equipment to enable students participate actively in workshop activities.

(iv) Teachers of Basic technology should be exposed to various teaching strategies by organizing workshops for them.

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LECTURERS' AWARENESS, CHALLENGES AND UTILIZATION OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) RESOURCES IN CONTENT DELIVERY IN FEDERAL COLLEGES OF EDUCATION IN NIGERIA

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Abstract

This paper investigated the Lecturers' Awareness, Challenges and Utilization of Information and Communication Technology (ICT) in content delivery in Nigeria. Three research questions were used to guide the study. A Survey research design was adopted to conduct the study. The target population was five thousand and seventy one (5,071) lecturers of Federal Colleges of Education in Nigeria. Sample size of eight hundred and forty three (843) lecturers of F. C. E. T. Asaba, Adeyemi COE Ondo, F. C. E. Katsina, F. C. E. Okene, Avan Ikoku COE Owerri and F. C. E. Yola were selected using cluster sampling technique. A modified questionnaire tagged Teachers ICT usage survey from the ICT Survey Indicator for teachers and staff developed by both UNESCO (2004) and the New Zealand Ministry of Education (MINEDU) (1999) was used for data collection. Face and content validity used to validate the instrument and reliability co-efficient of 0.96 was found using the Cronach's Alpha Reliability Coefficient obtained. Frequency count was used to answer research questions. The findings of this study revealed that lecturers were not well exposed and proficient in using ICT resources in content delivery. This study also confirmed that lecturers are face with challenges in using ICT resources in content delivery. This study recommends, among others, that lecturers should possess necessary ICT skills, training and retraining that will enable them to use ICT resources in content delivery.

Keywords: ICTs, Lecturers' awareness, challenges, content delivery

Introduction

Information and communication technology (ICT) has no doubt changed the face of teaching and learning globally, and most nations are taking the advantages inherent in ICT to impact on the education sector. The field of education has certainly been affected by the penetrating influence of ICT worldwide and in particular developed countries (Hilty, 2008). ICT has made a very profound and remarkable impact on the quality and quantity of teaching, learning and research in the educational institutions (Yusuf, 2005). ICT has the potentials to accelerate, enrich and deepen skill to motivate and engage students in learning to help relate school experiences to work practices; to help create economic viability for tomorrow's workers, contribute to radical changes in school; to strengthen teaching and provide opportunities for connection between the school and the world.

Aribisala (2006) noted that ICTs are increasingly playing an important role in organizations and in society's ability to produce, access, adopt and apply information. He also viewed ICTs as the tools for the post-industrial age and the foundations for a knowledge economy due to their ability to facilitate the transfer and acquisition of knowledge. Stressing the importance of the use of ICT in education, Olorunsola, (2007) is of the opinion that through ICT, educational needs have been met; it changes the needs of education as well as the potential processes. The

message can be communicated through the email, telex or telephones particularly the mobile ones. The pervasiveness of ICT has brought about rapid technological, social, political and economic transformation, which has eventuated in a network society organized around ICT (Yusuf, 2005).

Several efforts were made to inculcate ICTs development in Nigeria, Agbonlahor, Bamitale and Okike (2002) reported that the Nigerian National Universities Commission (NUC) in 1995 embarked on a project to link all Federal Universities electronic network named NuNet (Nigerian Universities Network) with the ultimate aim of establishing interconnectivity (including Internet) among the Universities. According to them, the project was halted due to some logistic problems. However, a preliminary evaluation of ICTs initiatives by government and non-governmental agencies has not been as successful as they ought to be. For example, Gambari and Adaeze (2007) observed that ICTs inadequacy in academic institutions was invigorated by budgetary constraints while Oketunji (1999) opined that most lecturers are not aware of the vast resources available on the Internet in developing countries.

Presently, the World statistics of Internet usage in Nigeria is 43.9 million. This is still very low for a country that has over 140 million people. In addition to the aforementioned, recent development indicates that improved access to Internet was basically spurred by the emergence of private companies that were interested in offering Internet services and were allowed to use Very Small Aperture Terminal (VSAT) for efficient services. However, Adeogun (2003) observed that rapid accessibility is sometimes faced with problems either in getting connected or retrieving information in developing countries. Not only that, the apathy of some lecturers in the use of Information and Communication Technologies (ICTs) has been a bottleneck in acquiring information on the Internet.

Other factors can be traced to socio-psychological phenomenon or personal belief in the efficacy of adopting the new technology. The ability to use the Internet by lecturers' is likely to be influenced by their beliefs. That is, lecturers' perception about their capacity to work effectively using the Internet will stand as a factor in determining their patterns of information usage. In order to build on existing knowledge, ICT today offers new opportunities for easy dissemination. However, this depends on the lecturers' awareness and utilization of ICT for content delivery.

Statement of the Problem

A wide range of educational application, ICT is being used to improve the efficiency, accessibility and quality of learning process in education. ICT offers new and innovative mode of learning for teachers and students in schools; it bring about classroom without walls when teachers realize the enormous potentials of this resources (Adekomi, 2006). But on the contrary, it was observed that many lecturers hardly comprehend the benefit of ICT in teacher education. Okebukola (1997) observed that ICT resources like computer, smartboard projector and many others are not used in content delivery in most tertiary institutions in Nigeria, thus the lecture method and course materials/ handout continue to dominate instructional delivery in tertiary institutions.

This is an indication that the teachers are still lagging behind in the trend of changes in the world of ICTs. This presupposes that there is the tendency for the students and teachers to be denied the opportunities which ICT offers in the teaching-learning activities. Beside, many

Nigerian teachers have been unable to find effective ways to use technology in their content delivery or any other aspect of their teaching. The use of ICT resources in content delivery is still a mirage, hence the need to investigate the lecturer's perception on the use of ICT resources for effective content delivery in Federal College of Education in Nigeria.

A major gap in most institutions in Nigeria in the onset of the 21st century is the gap in the availability and accessibility of knowledge. In the light of these, therefore, this study intends to investigate the Lecturers' Awareness, Challenges and Utilization of Information and Communication Technology (ICT) in content delivery in Nigeria.

Objectives of the Study

The objectives of the study are to:

(i) Examine the level of awareness of Federal Colleges of Education lecturers on ICT resources?

(ii) Find out the types of the ICT resources that available and used for content delivery for Federal Colleges of Education in Nigeria?

(iii) Find out the challenges lecturers faces in the use of ICT resources for content delivery in Federal Colleges of Education in Nigeria.

Research Questions

The study would seek answers to the following research questions:

(i) What is the level of awareness of Federal Colleges of Education lecturers on ICT resources?

(ii) What types of the ICT resources available and used for content delivery in Federal Colleges of Education in Nigeria?

(iii) What are the challenges lecturers faces in the use of ICT resources for content delivery in Federal Colleges of Education in Nigeria?

Research Methods

This study adopted survey research design. Survey is used in studies that have individuals as units of analysis (Babbie, 2001). This is also what Nworgu (1993) described as allowing a group of people or items to be studied by collecting and analyzing data from only a few people or items to be considered as representative of the entire group.

The population of the study comprises of all the lecturers in Federal Colleges of Education in Nigeria. They are five thousand and seventy one (5,071) in number.A sample size of eight hundred and forty three (843) lecturers was used for the study; using cluster, simple random and proportional sampling techniques. A modified questionnaire tagged Teachers ICT usage survey from the ICT Survey Indicator for teachers and staff developed by both UNESCO (2004) and the New Zealand Ministry of Education (MINEDU) (1999) was used for data collection. The validation of the instrument was established by two specialists in the field of educational technology and one from measurement and evaluation. The instrument possessed content validity and was subjected to Cronbach's Alpha Reliability Coefficient. A reliability co-efficient of 0.89 was obtained. Data collected were analyzed using mean scores and standard deviation. For an item to be accepted as agreed it has to have a mean score of 2.50 and above while, items that score a mean of below 2.50 are regarded as disagreed.

Results

The results of the analysis are shown below:

Research Question 1: What is the level of awareness of Federal Colleges of Education lecturers on ICT resource?

Table 1: Mean and standard deviation of FCE lecturers on the level of their awareness on ICT

S/N	Items	X	SD	Remark
1	I am aware that computer can be used for content delivery	2.85	1.38	Agree
2	I am aware that computer can be used to assess students' Performance	2.59	1.22	Agree
3	I am aware that computer can be used for keeping students' records.	3.30	1.60	Agree
4	I am aware that ICT motivates teaching and learning	3.24	1.54	Agree
5	I am aware that AUTOCARD is an important package for teaching and learning in graphics	2.35	1.78	Disagree

The results in table 1 showed that the mean responses of the lecturers are 2.85, 2.59, 3.30, 3.24 and 2.35 and standard deviation of 1.38, 1.22, 1.60, 1.54 and 1.78. All the items were accepted as agree except item 5 which scored disagree. The results indicate that lecturers who took part in the study are fully aware the use of ICTs in content delivery.

Research Question2: What types of the ICT resources are available and used in content delivery in Federal Colleges of Education in Nigeria?

Table 2: Mean responses and standard deviation of lecturers on the types of ICT resources that available and used for content delivery

S/N	Items	X	SD	Remark
1	Hardware like computers, printer, scanner, camera etc are available and used in content delivery.	2.75	1.34	Agree
2	Software like online database, invisible websites, subject directory, excel, are used in content delivery.	2.39	1.99	Disagree
3	Internet are used to obtain information for content delivery.	2.40	1.98	Disagree
4	Ict infrastructures are available for content delivery.	2.45	1.94	Disagree
5	Smartboard and power point projectors available and Used for presentation of lessons.	2.47	1.88	Disagree

Table 2 indicates that all the items scored less than 2.50 except item 1 which had a mean score of 2.75 and standard deviation f 1.34. It can be therefore, said that ICT resources are not available and are not used in content delivery in FCE in Nigeria.

Research Question 3: What are the challenges lecturers faces in the use of ICT resources for content delivery in Federal Colleges of Education in Nigeria?

Table 3: Mean responses and standard deviation of lecturers on the challenges faced in the use of ICT resources for content delivery

S/N	Items	X	SD	Remark
1	Lecturers' inadequate ICT skill.	3.50	1.66	Agree
2	Insufficient knowledge of appropriate software.	2.40	1.98	Disagree
3	Insufficient knowledge	2.40	1.98	Disagree
4	Irregular power supply. Inadequate facilities to support the full application of ICT	2.42	1.91	Disagree
5	Poor infrastructure	2.38	2.00	Disagree

The results in table 3 showed that all the items were accepted as disagree because they had a mean score of less than 2.50. Only item 1 scored a mean of 3.50 and a standard deviant of 1.66. The result shows that lecturers in FCE are faced with serious challenges in the use of ICTs in content delivery.

Findings

(i) Lecturers who took part in the study are fully aware the use of ICTs in content delivery.
(ii) ICT resources are not available and are not used in content delivery in FCE in Nigeria.
(iii) Lecturers in FCE are faced with serious challenges in the use of ICTs in content delivery.

Discussion

The finding of this study reveals that most of the lecturers in FCE are aware the use of ICTs in content delivery. The finding of this study thus confirmed the proposition of UNESCO UNEVOC (2009) which states that information and Communication Technologies (ICT) are becoming increasingly important in education and training and are opening up new learning pathways which can provide wider spread access to education and training.

The finding from this study shows that ICT resources are not available and are not used in content delivery in FCE in Nigeria. This finding also corroborates with the findings of Adeogun (2003) rapid accessibility is sometimes faced with problems either in getting connected or retrieving information in developing countries This also agreed with the findings of Gambari and Adaeze (2007) observed that ICTs inadequacy in academic institutions was invigorated by budgetary constraints while Oketunji (1999) opined that most lecturers are not aware of the vast resources available on the Internet in developing countries.

Similarly, the finding of this study is in consonance with that of Onasanya, Shehu and Oduwaiye (2010) that the level of competence and skill acquisition of colleges of education and polytechnics lecturers in the use of ICT facilities and equipment is discouraging. The result from this study also shows that lecturers in FCE are faced with serious challenges in the use of ICTs in content delivery. This finding support Yusuf (2005a) and Ofodu (2007) who submitted that lack of knowledge of how to evaluate the use and role played by ICT in teaching, Inadequate facilities to support the full application of ICT and irregular power supply in the country is a major obstacle to the use of ICT in education.

Conclusion

It is concluded from this study that lecturers in Federal Colleges of Education are aware of the existence and importance of ICT in content delivery. The study also found that ICTs like Smart board and power point projector are not available and used for presentation of lessons by the FCE lecturers in their content delivery. There were a lot of challenges to the effective use of ICT resources in content delivery by lecturers in FCE. The study showed that the major challenge lectures face in using ICT in content delivery in FCE is irregular power supply. There is therefore, the need for the government to provide ICT facilities available for teaching and learning in tertiary institutions in Nigeria and also stable power supply.

Recommendations

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

(i) Lecturers should possess necessary ICT skills that will enable them to use ICT resources in content delivery. There should be workshops, seminars, conferences in-service training and capacity building training programmes and skilled development of teachers that will encourage them to have the requisite skill, competence and exposure to enable them to be more proficient in using ICTs in teaching/learning activities.

(ii) The government should ensure that a stable power supply is provided in the country. This will go a long way in making ICT or e-learning practicable in FCE.

(iii) The government should increase funding for the educational sector with emphasis on ICT that will help improve the level of ICT facilities in the schools.

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ANALYSIS OF MISCONCEPTIONS IN ALGEBRAIC EXPRESSION AMONG SENIOR SECONDARY SCHOOL STUDENTS OF DIFFERENT ABILITY LEVELS IN KATSINA STATE

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Abstract

The study employed the content analysis procedures to analyze major misconceptions of different ability students in algebraic expression at senior secondary school level. Sixty (60) senior secondary school III students from the three senatorial districts in Katsina State were stratified and randomly sampled. The researcher used Students Mathematical Test (SMAT) to group the students into different ability levels- high, medium and low and Students' Algebraic Expression Misconception Test (SAEMT) to explore the students' misconceptions in the algebraic expression concepts. Contingency table and Cramer's V were used to answer the research questions while Chi-square test of independence was used to test the statistical significance of the study. The findings showed that invalid/insufficient premise for algebraic manipulations, deficient belief about algebraic structure and restructuring, value mind fixed answers and specific misconceptions categories are found to be the major misconceptions of students of all ability level. The result further indicates these misconceptions significantly related to (a) students' ability with small effect size $\chi^2(df= 6, p< 0.005)= 21.621; V= 0.20$ *and (b) error distribution in algebraic expression concepts with small effect size* $\chi^2(df= 6, p< 0.001)= 26.888; V= 0.21$ *respectively. The study recommended among others that mathematics teachers, in respective of the ability of the students in mathematics, should give equal attention and treatment to their students' difficulties especially in algebra classes.*

Keywords: Algebra, Algebraic Expression, Misconception, Error, Ability levels

Introduction

Algebra is a cardinal concept in the school mathematics curriculum. Many historically developed algebraic concepts can be observed in the current secondary school algebra curricula throughout the world (Egodawatte, 2011). Algebra, as described by Adeniji and Ibrahim (2015), is a branch of mathematics in which symbols (usually letters of alphabet) represent numbers or numbers of a specified set and are used to represent quantities and to express general relationship that hold for all numbers of a set. This description further explains why its inclusion in the school curricular becomes imperative and how various structural features are connected together to form broader conceptions within algebra in conformity with its historical development.

Wiki answers (2012) listed some of the uses of Algebra as many companies' tools to figure out their annual expenditures, to predict the demand of a particular product and subsequently place their orders for various stores. Algebra expression and equation serve as models for interpreting and making inferences about data.

Following all these points about algebra, it is obvious that students overall mathematics achievements and its subsequent applications in the today's world activities largely depend on

algebraic concepts proficiency. However, many efforts to improve Students' algebraic competency have not translated to greater achievement especially at senior Secondary School level. Many are even discontinuing their study of higher-level mathematics because of their lack of success in algebra (Egodawatte, 2011). As result of this, it becomes imperative on the researcher in the field of teaching and learning to study the possible misconceptions students may have in their algebraic classes.

Obviously, there are many factors responsible for students' misconceptions in algebra especially in the algebraic expression concepts, but lack of robust support from researchers in the field of teaching and learning are still noticeable (Seng, 2010). Algebraic expressions contain variables (letters), constant and operational signs. Hence, there is a need for students to understand algebraic structures and the meaning of letters at different situations for them to solve them correctly. According to Bodin and Capponi (1996), the concepts of variables vary with the situation of the problem that students have to handle. This idea of a variable is not only to represent a particular value but can also represent different values at different situation further compound the students' difficulties in handling algebraic expression related problem.

Many conception and misconception have been identified in the literature regarding algebraic expression. Egodawatte (2011), in order to put it in its real perspective, further categorized algebraic expression as expression simplification, evaluation comparing, building and equivalence. This categorization presents opportunity to students to have clear understanding of algebraic expression structures and to mathematics educators and researchers to deeply investigate the possible misconceptions student may have/hold in their algebraic lessons. Those misconceptions identified in the literature include Hallangan's (2006) comment on a teacher model in which students were asked to visually represent an algebraic expression given in four different forms. The same expression was given in four different forms: $4(s+1)$, $s + s + s + s + 4$, $2s + 2(s + 2)$, $4(s + 2) - 4$. A square pool with measurements $s \times s$ and a small square with measurements 1×1 were given as pictures to illustrate the border of a square pool in four different ways related to the above four expressions. There were four main conclusions. First, transition from arithmetic to algebra takes time for students. Second, students preferred numerical answers and to conjoin algebraic terms. Third, on a positive note, visual representations helped students to understand the algorithms in algebra. Fourth, students could not understand the concept of a variable clearly.

Conjoining letters in algebra is to connect together the letters meaninglessly. Researchers (e.g Tall & Thomas, 1991; Stacey & MacGregor, 1999;Egodawatte, 2011) have differences of opinions about reasons for this error. Due to similar meanings of 'and' and 'plus' in natural language, students may consider ab to mean the same as $a + b$ (Tall & Thomas, 1991; Stacey & MacGregor, 1999). Students may erroneously draw on previous learning from other subjects that do not differentiate between conjoining and adding. For example, in chemistry, adding oxygen to carbon produces CO_2 (Egodawatte, 2011).

Kychemann in Seng (2010) also descried some misconceptions which involved students' reluctance in accepting algebraic statement as an answer instead they tend to give numerical values. In addition, student errors were also noticed when expanding bracket with negative signs. This type of error occurs as a result of students' insufficient knowledge of distributive properties of algebra (Ayres, 2000; Sakpakorn & Haries, 2003; Adeniji & Ibrahim, 2015). Understanding of basic arithmetic operation and high manipulating skills are basic criteria for

the success in acquisition of algebraic knowledge (Warren, 2003; Adeniji & Ibrahim, 2015). Lack of the structural features of algebra causes many types of misconceptions student have when solving algebraic expression related problems. Misconception is referred to as logically persistent and rule based errors committed by students when solving mathematical problems. Because students have logically constructed their misconceptions from their experiences, they are very attached to them, convincingly belief in them and find it very difficult to give them up.Thus, there is an urgent need to analyse the possible misconceptions of students of different ability levels may have when given algebraic expression related problems.

Various approaches are being used by mathematics educators and teachers to enhance students' mathematics learning, among them is ability grouping approach. The practice according to rationalists' ideal facilitates teaching and learning by enhancing both teachers and students' adjustment. This is because if those in the medium and low ability group are identified, teachers and school system can give more attention and provide intervention program for them. But studies in the area of students' error and misconceptions have shown that even students considered as higher achiever can also hold some unexpected mathematical misconceptions. For instance, Kirshner (1985) confirmed that over-generalization of rules is common in almost every student even successful one before achieving fluency in manipulation skills. Thus, assessing students' errors and misconceptions in mathematics, especially in algebra, is highly inclusive and worthwhile.

Basic algebraic concepts in secondary school algebra are closely linked. If we could study those concepts together in a study and examine the interrelationship among error patterns, it would present bases for predicting students' errors and misconceptions for meaningful engagement by the teachers and other stakeholders in mathematics education.

Statement of the Problem

In recent years, many research works on mathematics education have focused on learning difficulties of students related to algebra (Wu, 2001; Norton & Irvin, 2007; Egodawatte, 2011; Adeniji & Ibrahim, 2015). Research (Norton & Irvin, 2007), suggested that solutions to the problem of students inability to be successful in algebra are many and interconnected. Many findings have also related students' errors in algebra to fundamental differences between arithmetic and algebra (Wu, 2001; Stacey & Chick, 2004; Norton & Irvin, 2007; Egodawatte, 2011; Adeniji & Ibrahim, 2015). Despite all these researches and their suggestions no attempt has been made by researchers to study the nature of each component of algebraic conceptions in relation to difference mathematical abilities of students in Nigerian secondary schools so as to look deep into the peculiarities of algebraic difficulties of these different groups of students. As a result, this study employs content (Thematic) analysis method to discover major misconceptions of mathematics students of different abilities in basic algebraic expression concepts in senior secondary school. These approaches would not only empower teachers to adopt and implement appropriate strategies in their teachings but also provide insight into how curriculum developers and textbooks writers can professionally engage these misconceptions/errors.

Objectives of the Study

The study has the following objectives:

(i) To identify major misconceptions commonly held by Senior Secondary School Student of different performance ability in algebraic expression.

(ii) To determine the extent to which these major misconceptions predict students' (i) performance ability and (ii) error distributions in algebraic expression concepts.

Research Questions

(i) What are the major misconceptions of high, medium and low ability students in algebraic expression concepts?

(ii) To what extent will significant relationship exist between major misconceptions of high, medium and low ability students and the (i) students' ability level (ii) error distribution in algebraic expression concepts?

Null hypothesis

HO_1: There is no significant relationship between major misconception of high, medium and low ability students and the students' (i) performance ability level (ii) error distributions in algebraic expression concepts.

Methodology

This study adopted descriptive survey research design. According to Fraenkel and Wallen (2006), any data generated to identify important variables and to further generate hypotheses for future research is exploratory. Thus, the data obtained were used for exploratory purposes.

The population for the study consists of all SSS III students in all the seven educational zones of Katsina State of Nigeria. There are 188 senior secondary schools and 30,541 students of SSS III in Katsina state. All SSS III in all the seven educational zones were stratified into the three senatorial districts of the state (North, Central and South) and adequate proportion of students with respect to their ability levels were randomly selected from each. This technique was adopted, as stressed by Fraenkel and Wallen (2006) and Kothari and Garg (2014), because of its strength at increasing the likelihood of representativeness. Therefore, this technique was used for selecting sixty (60) students which consist of 20 students for each ability level.

The study employed two instruments namely: Students Mathematical Ability Test (SMAT) and Students Algebraic Expression Misconception Test (SAEMT). The SMAT was prepared by the researcher to group students into three different mathematical ability levels. The SMAT contained 40 items multiple choice of five options A to E from critical aspects of mathematics curriculum at secondary school level. These aspects are Algebra, Arithmetic Process, Geometry and Probability & Statistics. The SAEMT was prepared to obtain data about students' understanding of algebraic expression concept by including a variety of items. The test contained 5 essay items which further categorized algebraic expression as simplification, equivalence and Building. To ensure the content validity, both SAEMT and SMAT were prepared by consulting the Katsina State Mathematics Teaching Scheme; SSS1-SSS3 (Ministry of Education, 2006) as a basis. The split-half method was used to establish the internal consistence (Reliability) of the two tests after administration to 25 students who did not take part in the study. The reliability coefficient for the whole test (R_f) using the Spearman-Brown prophecy formula was 0.86 and 0.83 for SAEMT and SMAT respectively.

Data Analysis

The data analyses in this study involved two procedures namely: Students grouping and Rubric construction. To group students into different ability levels, procedures from Almeida and Freire in Ferrando et al. (2012) was adopted. Thus, students were grouped into High ability (those

with score 75 percentile and above), Medium ability (those with score between 75 and 25 percentile) and Low ability (those with score 25 percentile and below).

For rubric construction, the researcher painstakingly analyzed the students' procedural and conceptual errors in SAEMT in order to infer their misconceptions. The process consisted of the following: identification of errors, description of errors, classification of errors, quantification of errors and making inferences of underlying misconceptions of these errors. This method of analysis used was described by Sambo (2005) and Fraenkel & Wallen (2006) as content (thematic) analysis. Being categorical data, the researcher employed frequency counts, percentages calculations, contingency (Crossbreak) table, Cramer's V (Effect size) to answer the research questions while Chi-square test of independence analysis was used to test the statistical significance of the findings of the study.

Results

Question 1: What are the major misconceptions of high, medium and low ability students in algebraic expression concepts?

Table 1: Distributions of Algebraic Misconceptions and Error Category of High, Medium and Low Ability Students in Expression

Students' ability	Major Misconceptions	Sub – error Category	% Occurrence
High	Invalid/insufficient premise for algebraic manipulation	• Invalid simplification(39.0) • Incomplete simplification (12.2) • Wrong Algorithm(3.7) • Invalid distribution(6.1)	60
	Deficient belief about algebraic structure and restructuring	• Convert algebraic factors & expression to equation(9.6) • Unnecessary balancing(1.2)	10
	Value mind fixed answer	• Obtaining value for algebraic expression(1.2) • Convert algebraic expression to arithmetic(1.2)	2
	Other misconceptions	• Inadequate factorization procedure(6.1) • Misinterpretation error(6.1) • Miscellaneous errors(13.4)	28
Medium	Invalid/insufficient premise for algebraic manipulation	• Invalid simplification(39.0) • Operational deficiency(4.3) • Invalid distribution(5.8) • Incomplete simplification(0.7)	50
	Deficient belief about algebraic structure and restructuring	• Convert algebraic expression to equation(13.0) • Unnecessary balancing(0.7) • Illegal separation of algebraic term(1.4) • Lack knowledge of algebraic structure(2.8)	17

	Value mind fixed answer	• Obtaining value for algebraic expression(1.4) • Convert algebraic expression to arithmetic(2.8) • Substituting arbitrary values for simplification(1.4)	5
	Other Misconceptions	• Misinterpretation error(4.3) • Wrong factors(1.4) • Miscellaneous error(21.7)	28
Low	Invalid/insufficient premise for algebraic manipulations	• Invalid simplification(46.8) • Wrong algorithm(8.5) • Invalid distribution(4.3) • Incomplete simplification(3.2)	63
	Deficient belief about algebraic structure and restructuring	• Convert algebraic expression to equation(4.3) • Illegal separation of algebraic term(1.1) • Lack knowledge of algebraic structure(3.2)	9
	Value mind fixed answer	• Obtaining value for algebraic expression(6.4) • Convert algebraic expression to arithmetic(3.2) • Substituting arbitrary values for simplification(5.3)	15
	Other Misconceptions	• Wrong factorizations(1.1) • Miscellaneous error(11.7) • Reversal error (1.1)	13

Table 1 shows that students of high, medium and low ability build their misconceptions in algebraic expression on the same ground as they all recorded invalid/insufficient premise for algebraic manipulations, deficient belief about algebraic structure and restructuring, value mind fixed answers and other misconceptions with percentage occurrence. Misconception which based on invalid/insufficient premise for algebraic manipulations is a group of students' error categories that describe invalid procedures for expression simplifications, wrong algorithms, invalid distribution for equivalent expression and incomplete simplifications.

Deficient beliefs about algebraic structure and restructuring based misconception described notion of students to illegally change the structure of algebraic expression given in order to simplify, build or show equivalent of expression at will. This misconception has illegal conversion of expression to equation, illegal separation and transformation of algebraic terms, unnecessary balancing and lack knowledge of algebraic structures. The researcher used value mind fixed answers misconception to describe students' error categories which rooted in believing that all mathematical problems must have value answers. This can be seen from the error categories that make up the misconception from obtaining illegal values for algebraic simplification to conversion of algebraic expression to arithmetic and substituting arbitrary values to obtain their answers.

And lastly, other misconceptions are categories of errors that are specific to a certain concept in algebraic expression and errors whose procedures cannot be linked to any known mathematical algorithms but can still be investigated further. These categories include wrong/inadequate factorization technique, misinterpretation errors and miscellaneous errors.

Question 2: To what extent will significant relationship exist between major misconceptions of high, medium and low ability students and the students' (i) ability level (ii) error distributions in algebraic expression concepts?

Table 2: Relationship between students' ability levels, error distributions and common misconceptions in algebraic expression problems

Variables	Row	Column	N	df	χ^2-cal	χ^2-tab	V	Remark
Students ability	4	3	314	6	21.621	18.5476	0.20	*S
Error distributions	4	3	314	6	26.888	22.458	0.21	**S

*S= Significant at p <0.005 **S= Significant at p< 0.001 V= Effect size

Table 2 shows that there is a significant relationship between the students' ability and their common misconceptions in algebraic expression problems χ^2(df= 6, p< 0.005)= 21.621 and the null hypothesis which states that there is no significant relationship between the two variables is rejected. Information provided by the Table 2 also indicates that χ^2 calculated (26.888) at p< 0.001 is greater than χ^2 critical (22.458). Then, the null hypothesis which states that there is no significant relationship is also rejected Thus, we conclude that invalid/insufficient algebraic manipulations, deficient belief about algebraic structure and restructuring, value mind fixed answers and other misconceptions are significantly related to students' ability and error distributions among algebraic expression concepts with small degree of association (V= 0.20, 0.21) respectively.

Discussion

Analysis of students' responses to SAEMT recorded 314 error types. Three and some specific misconceptions termed as "other misconceptions" were inferred as commonly held misconceptions under this concept and they were found to be significantly related to students' abilities and error distributions in algebraic expression with small degree of association (effect size) respectively. Firstly, invalid/insufficient premise for algebraic manipulations based misconception described students belief that is built on unrecognized procedures for algebraic expression simplifications which include over-simplification, incorrect cross multiplication; wrong algorithms, invalid distribution for equivalence expression and incomplete simplifications. This finding supports (Egodawatte, 2011; Adeniji & Ibrahim, 2015).

The reasons given in the literatures for invalid simplification especially oversimplification include conceiving open algebraic expression as 'incomplete' and try to finish them by over-simplification, and due to nature of mathematical notations as processes and objects (Tall & Thomas, 1991; Stacey & McGregor, 1994) or erroneously draw on previous learning from other subjects (Egodawatte, 2011).

Secondly, deficient belief about algebraic structure and restructuring based misconception captured students' misconception that illegally prompted them to change the structure of a given algebraic structure to simplify, build and show its equivalence. One of the error categories under this misconception is illegal conversion of expression to equation which agreed with (Egodawatte, 2011; Adeniji & Ibrahim, 2015). Others are illegal separation/transformation of algebraic terms, unnecessary balancing and inadequate knowledge of algebraic structures.

Thirdly, misconception rooted in value mind fixed answers. This is a students' belief that mathematical problems must have value answers. The error categories that made this conception are obtaining illegal values, substituting arbitrary values for algebraic expression and erroneous conversion of algebraic expression to arithmetic to obtain value answers. This finding is in agreement with (Bodin & Capponi, 1996; Egodawatte, 2011; Adeniji & Ibrahim, 2015). Egodawatte (2011) gave the reason for some of these errors as when students used equal sign to indicate 'the next step is' or, in order words, when the equal was used as a 'step maker' (p.137).

And lastly, some error categories that are only specific to certain concepts in algebraic expression related problems merged together to have a category tagged other misconceptions. These groups of misconceptions consist of misinterpretation/reversal error of word framed questions, wrong factorization techniques and miscellaneous errors. These sorts of errors were also indicated in the literature (Egodawatte, 2011; Adeniji & Ibrahim, 2015). Available literatures lack the information on how major misconceptions of students predict their performance ability in mathematics and error occurrence in algebra concepts.

Conclusion

Based on the procedures and statistical inferences made from this study, it could be concluded that invalid/insufficient premise for algebraic manipulations, deficient belief about algebraic structure and restructuring, value mind fixed answers and some specific misconceptions categories such as misinterpretation/reversal error of word framed questions, wrong factorization techniques and miscellaneous errors are the commonly held misconceptions of high, medium and low ability senior secondary school students in algebraic expression related problems. Furthermore, these misconceptions can predict students' performance ability level in mathematics and their error distributions among algebraic expression concepts to the degree of 20% and 21%. It could also be concluded from the analyses conducted in the study that students of different performance ability level in senior secondary school are likely to hold the same naive belief about algebraic concepts making ability grouping very much unnecessary when teaching algebra concepts.

Recommendations

It becomes imperative to make the following recommendations as a result of the major findings of the study:

(i) Mathematics teachers in secondary school should pay attention to all the misconceptions discovered in the study and design thoughtful instructional methods to handle them in their algebraic classes in respective of the ability level of the students.

(ii) Mathematics teachers especially those in primary schools where the basic concepts of arithmetic start should be exposed to training which will enhance their effective teaching of the concepts. This will play a very prominent role in the mastery of algebraic concepts.

(iii) Curriculum planners and Textbook writers should take into cognizance of all the error categories that constitute students misconceptions when designing curriculum and textbooks to facilitate teachers' algebraic teaching and cancel students naïve belief/notions.

(iv) Researchers in the field of mathematics education should try further to investigate the reasons behind students' errors in concepts such as Evaluation and Comparing algebraic expression that are not investigated in this study.

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FUNCTIONAL MATHEMATICS EDUCATION: A PLATFORM FOR INNOVATION AND ENTREPRENEURSHIP DEVELOPMENT IN SCIENCE AND TECHNOLOGY EDUCATION

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Abstract
The paper dwelt exhaustively on Mathematics education as the foundation for science and technology which provide the necessary entrepreneurship learning experiences for self employment. It examined the Potentials in functional mathematics for Entrepreneurial Development. In another development the paper examined the challenges for mathematics educators which is characterized by inadequate manpower training and development that will ensure regular updating of skills, adequacy of content and instructional materials in schools. It was recommended that In-service should be organized for mathematics teachers to update their knowledge in line with advancement in science and technology.

Keyword: Development, Entrepreneurship, Functional mathematics, Innovation

Introduction
The Nigerian Education system that is in practice today was as a result of the colonial education which Nigeria had under the British Government. Although there aim was primarily for the purpose of training Nigerians for the needed white collar jobs to enhance their administration in Nigeria. The trend up till today is still deeply rooted in the mind-set of Nigerians forgetting the fact that the goal of education has since changed with reference to the National policy on education Federal Republic of Nigeria (FRN) (FRN, 2004). Having realized the effectiveness of education as a powerful instrument for national progress and development, the education philosophy and methodology has been matched with the ideals and challenges of changing economic and social structures of modern society. To this end, Dorothy (2011) as cited by Bilya (2013) states that the important thing that ever happened to Nigeria is the 1981 National Policy on Education, which emphasizes its broad aim and objectives of secondary education as the preparation for useful living within the society and preparation for higher education. However, the aim of preparing secondary school student and of course graduates for useful living has been defeated; this is because for about three decades now, majority of Nigerian youth are idle while some are involved in various vices due to unemployment. According to Tsafe (2014) unemployment is extremely high and the vulnerable categories of people are the youth, low-skilled and immigrant workers. For instance, unemployment is so rampant that recently there was a stampede which led to the death of many Nigerian youth in various centers across the country, during Nigerian Immigration Service aptitude test. This is an indication that unemployment in Nigeria is on the high side. Accordingly, the 6-3-3-4 Nigerian Education system was evolved with such regard toward producing individuals with physical and mental skills and competence that will enable individuals contribute to the development of the society

(FRN, 2004). Oli (2000) opines that to ensure a positive future of Nigeria, the youth who are believed to be the future leaders are expected to be equipped with basic necessary skills to drive the economy. Similarly, reviewing Mathematics Education curricula to align with the demand of industries could provide required skills for self employment. As a science course, Mathematics is concerned with overall physical development which is necessary in technology thereby providing job to individuals. The prosperity of any country therefore depends on the volume and the quality of mathematics offered in its school system (Eze, 2010). The relationship which mathematics has with the society and other fields of knowledge such as entrepreneurship education is best seen when one considers the national objectives of primary and secondary education as they relate to mathematics education.

Concept of Entrepreneurship

Various scholars have defined entrepreneurship globally as a potential tool for industrialization and rapid economic growth of any society. On one extreme, it is seen as the creation of new business and bearing risks therein in the attempt to create value in business opportunity. In confirmation, Reynolds (2013) affirmed that entrepreneurship is participation in new business creation that made one to be self employed. Abubakar and Babalola (2011) described entrepreneurship as a creative activity. It is the ability to create and build something from practically nothing. Akpomi (2009) stressed that entrepreneurship has been extended to include element not necessarily to business formation activity such as specific mindset relating in entrepreneurial initiative, for instance in the form of social, political or knowledge entrepreneurship. For European Commission (2004) entrepreneurship was viewed to include planning, communicating, doing, evaluating and record process in learning. This implied that entrepreneurship is geared towards creating new system processes, mobilizing men, materials, machines and financial resources in order to produce new product and or serve new market. The National Universities Commission/Education Trust Fund (2004) report revealed that most Nigerian graduates lack entrepreneurial skills, one of the reasons advanced is that most teachers that teach the subject/course are professionally and academically incompetent.

In whichever way we look at the definition of entrepreneurship, a close look at the various definition revealed that entrepreneurship is an attempt to create value through recognizing the business opportunities, combining and bringing together both human and material resources necessary for bringing out a project to function.

Objectives of Mathematics Education

The report of the mathematics conference of the Mathematical Association of Nigeria (MAN) held in Benin, between the 6th and 7th January 1977, gave the summary of the National objectives of Primary and Secondary Education as it relate to Mathematics Education to include:

(i) To lay solid foundation for the concept of numeracy and scientific thinking.
(ii) To give the child opportunity for developing manipulative skills that will enable him function effectively in the society within the limits of his capacity.
(iii) To provide the basic tools for advancement as well as prepare him for trade and craft of his locality.
(iv) To build on the foundation of primary level so that the child can make a useful living professionally, economically, politically and socially.
(v) To generate interest in mathematics and to provide solid foundation for everyday life.

(vi) To develop computation skills and to develop ability to recognize problems and to solve them with related mathematics knowledge.

Functional Mathematics Education: A platform for Entrepreneurial Development in Science and Technology

Functional mathematics education is the agent of transformation in this technological age Otunu (2013). It is a way of empowering the power for productivity and to train the students toward practical mastery of the subject, its application will give people a vocation rather than giving room to job seekers, as such Science and technology are functional Mathematics oriented which include trades and careers of all kinds. Through training, individuals are helped to acquire entrepreneurial skills, promote and establish small and medium scale business, gain access to income generating opportunities and gainfully be employed. Thus, Science and Technology of which mathematics is the basis are means of wealth creation. Tsafe (2014) opines that mathematics is important in all human endeavours; as such cannot be thrown overboard in every human decision to be taken, project to be executed, policy to be implemented or any study to be carried out. Mathematics is the key to development. The role being played by mathematics in day to day activities of man is suggestive of the fact that mathematics is needed by all, not only for scientific or technological development, but also for all forms of development (Eze, 2010). The socio-cultural, utilitarian and disciplinary values of mathematics worldwide also place the subject at a vantage position for ensuring all round sustainable development.

Mathematics is a science with the basic scientific skills and objectives; according to Abdullahi (2006), physical development is associated with performing physical tasks like the ability to move, lift, stand and manipulative objects. The ability to perform those physical tasks accurately is important in technology. Mathematics fosters physical tasks in geometrical constructions. If a learner is exposed enough to mathematical activities requiring manipulative skills, then, the learner could be able to grow to become a useful practical and industrious member of his community and hence create job for himself and others. This implies that mathematical activities take cognizance of physical development which is necessary in technology thereby providing jobs to individuals. It is only skilled people with entrepreneurial background that can create wealth and employ others(Eze, 2010).

According to Iweka, Onwuka, and Moseri (2010), Mathematics has long been a compulsory subject in the primary and secondary schools in Nigeria. In institutions of higher learning, competence in Mathematics is demanded for enrolment into a wide range of courses (Science and Technology)

Problem-solving skills is another functional mathematics which enable the students apply their skills to both familiar and unfamiliar situations, thereby giving them the ability to use tested theory and also create their own before applying them. By developing problem-solving strategies, students learns to understand problem, device plan, and carryout plan, analyze and review the accuracy of their solution. The methods involved in problem-solving develop the use of reasoning, careful and reasonable argument and decision-making which are essential ingredients for effective innovation in science and technology.

In our day-to-day life, mathematics is not a mere subject that prepares students for higher academic attainment or job qualification in the future. It is more about how it compels the

human brain to formulate problems, theories and methods of solution. It prepares children to face a variety of simple to multifaceted challenges that every human being encounters on a daily basis. In addition mathematical knowledge in every field of study and industry produces new discoveries and advancement of new disciplines. All innovation introduced worldwide, for instance card reader that was used in the recent 2015 election is a by-product science, technolgy and mathematics.

More so, Mathematics is a creative discipline. The language of mathematics is international. The subject transcends cultural boundaries and its importance is universally recognized. Mathematics education being an aspect of general education is also a major platform for innovation and entrepreneurial development. Today, the whole world is talking about technological development. A country cannot achieve technological breakthrough without functional mathematics education. We benefit from the result of mathematical research every day. For instance, the fiber-optic network carrying our telephone conservation was designed with the help of mathematics. Weather prediction, the design of fuel efficient automobile and airplane, traffic control and medical image; all depend on mathematical analysis. For Nigeria to be one of the 20 largest economy that could create jobs by the year 2020 it depends on how functional mathematics education is.

Creative thinking is an integral element in mathematics. It implies seeing ideas or objects in a different context either by recognizing their inherent potentials to be used in different ways or situation or by putting ideas together to create something new, (Abel, 2006). Creativity and initiatives are two components of inventions. A creative individual can never be poor and can easily manipulate situation to solve environmental and economic problems. The use of problem solving strategy for teaching mathematics is very important in teaching-learning situation in all levels of schooling to develop in the learner the skill of creativity. As it relate to entrepreneurship it enable the student to understand problem, device plan, and carryout plan, analyse and review the accuracy of their solution.

The idea of logic where the validity or conclusion rests upon the validity and consistency of the assumption and definitions upon which the conclusion are based will help to eliminate frequent conflicts in our societies. If the society is free to be of conflict then there shall be a level playing ground for entrepreneurs to operate.

The role of mathematics in commercial and technological development of the civilized nations and the general acceptance that mathematical methods are central to the solution of all kinds of problems have rightly enhanced the importance of Mathematics instruction in tertiary institutions (John, 2007). Mathematics consists of activities such as concept formation, abstraction, generalization, theory building and problem solving, which is the basic mathematical activity; all other activities are pre-requisite to it.

Though functional mathematics is a platform for innovation and entrepreneurial development in science and technology, yet there are far-reaching impediments for Mathematics educators.

Challenges for Mathematics Educators

The challenges of Mathematics educators as contained in the work of Nnenna (2010) are as follow:

(i) Mathematics is the subject that parents often recall with anxiety and frustration from their own experience

(ii) Although Mathematics is an abstract science, Mathematics education is very much a social endeavor, improving mathematics education requires among other things, thorough understanding of pressures that shape current educational practice.
(iii) The teaching of mathematics needs technological means of making it intresting, one of which is Information Communication Technology (ICT), yet many mathematics teachers lack the knowledge and application.

Strategies for Improving Functional Mathematics Education

The strategies for addressing the challenges of Mathematics educators, in particular and mathematics education in general are:

(i) Ensuring adequate provision of instructional materials for effective teaching and learning in schools
(ii) Establishing a sound program of manpower training and development that will ensure regular updating of skills.
(iii) In order to retain the quality of teachers in schools; condition of service should be improved for the teachers.
(iv) Constant review of Mathematics curriculum to meet the challenges and demand of the nation's industrial and entrepreneurial development.
(v) Involvement of science and Mathematics teachers in the education and industrial or entrepreneurial development.

Potentials in Functional Mathematics for Entrepreneurial Development

Mathematics is a course that touches the lives of the citizens through every human decision to be taken, policy to be implemented or any study to be carried out (Tsafe, 2014). It is in this regard that mathematics could be found in every sphere of life including employment generation and sustainability. A skillful mathematics graduate should be able to construct some of the mathematics teaching and learning resources. This materials could be categorize into two main aspect as contained in the work of (Alio, 2013):

(a) The teacher-made mathematics teaching materials
(b) The commercially-made teaching materials.

The teacher-made teaching materials are the materials which the teacher can make or construct by himself, such materials are the materials the teacher can improvise by himself. The teacher can teach the students how they could produce such materials by themselves. According to Alio (2013), such productions are necessary especially in schools where there are no ready-made instructional materials e.g Geoboard, chart of different types, tangram, cards, Rolleographs, cut-out shapes (templates), funnel boards, weighing balance, trundle wheel, graph board, clinometer, compass bearing, mathematical set, 3-Dimentional models, ladder etc. The commercially made mathematics teaching materials are mathematics teaching materials which are carefully developed by experts for sale in shops and markets e.g Computer, calculators, projector, measuring cylinder, slide rule etc.

With the above mentioned potentials, mathematics educators can become self reliant by opening centres where they could be producing some of these teaching resources. The centres could also become training grounds for others. He can admit apprentices who could help him in this production. The apprentices employed in turn pay for the training.

Textbook is one of the most important generators of information for a successful teaching and learning. Mathematics educators could become self-reliant through writing good text books in mathematics for all levels of education. These text books could be supplied to school libraries at local, state, and federal levels of education. At the same time, book shops could be opened where these books could be sold

Recommendations

(i) Having seen the place of mathematics, more effort should be made by the stake holders to popularize the need for mathematics and technology and also to generate and sustain students' interest in mathematics.

(ii) Mathematics teachers should encourage themselves and be encouraged to embrace information communication technology.

(iii) Mathematics teachers should be made to join professional associations within science education to understand and engaged in current issues within the field.

(iv) In-service should be organized for mathematics teachers to update their knowledge in line with advancement in science and technology.

(v) The state and federal governments should be willing to purchase materials developed by mathematics educators to schools

Conclusion

This paper has established Mathematics education as the foundation for science and technology which provide the necessary entrepreneurship learning experiences for self employment. Graduates from institutions of higher learning should understand the situation in which they find themselves, as such should utilize the education they have acquired to take good decisions for their self-survival in the society.

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