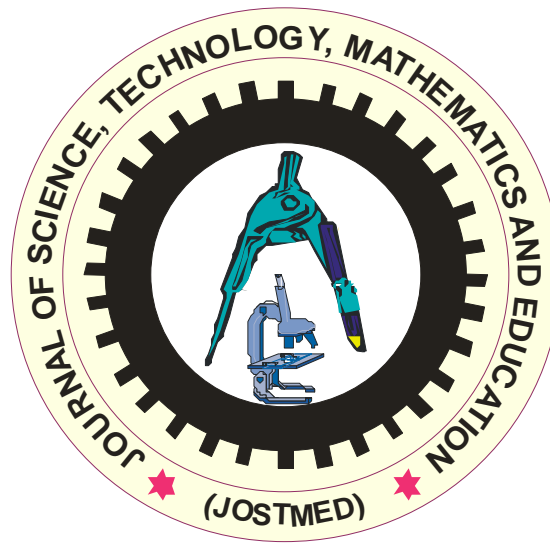


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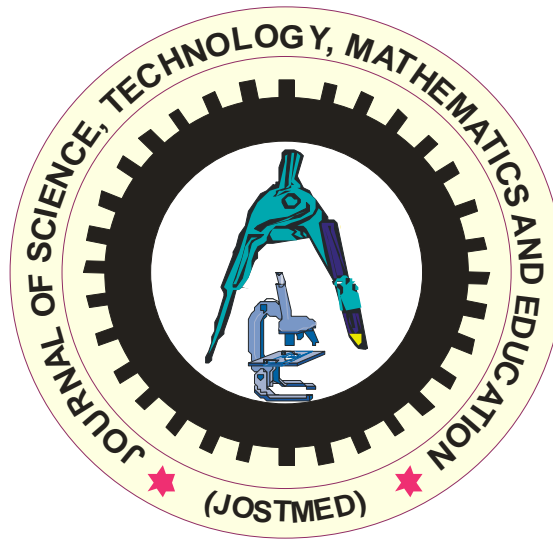
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**ARTICLES AND RESEARCH REPORTS
ON SCIENCE**

SURVEY OF INTESTINAL HELMINTHES AMONG DOMESTIC FOWLS IN IJEBU-ODE, SOUTH-WEST NIGERIA

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Abstract

A study was conducted in Ijebu-Ode to determine the prevalence of intestinal helminthes among domestic fowls. A total of 90 gastrointestinal tracts of slaughtered domestic fowls were collected from Oke-Aje Market of Ijebu Ode during the festive period. The samples included gastrointestinal tracts of 15 cockerels, 55 layers and 20 broilers. They were examined for the presence of helminthes using direct saline smear and formol ether concentration technique. The prevalence of helminthes was also studied through questionnaire by respondents who are farmers that sell to the vendors. Four helminth species were observed with overall prevalence of 41 (45.6%). A Cestode, Raillietina echinibothridia; 3 (5.8%) was the least. Ascarid, Capillaria concorta; 5 (9.6%), Heterakis gallinarium; 10 (19.23%) and Ascarida galli; 34 (65.38%) were the predominant species. Layers were the most affected birds 25 (71.4%), followed by Cockerel 8 (53.3%) and the least was broiler 8 (40%) and the differences were statistically significant ($P < 0.05$). Deduction from it revealed farmers out of curiosity to improve egg laying and introduction of balance diet had poultry feed supplemented with various additives both foreign and local which may have been contaminated with infective stage of worms as a result of non-hygienic practice. Lack of proper veterinary care and unreliable history of strategic anti-helminthes medications as well as poor sanitary conditions may contribute to contaminate poultry feed. Therefore, it is important to educate poultry farmers in the study area, the vital importance of early helminthes prophylaxis, strict disinfection of pen during the growth period of birds to reduce incidence of worms, the use of prescribed larvacide in the cleaning exercise to interrupt the life cycle of the parasite intermediate host.

Keywords: Helminthes, prevalence, domestic fowl, gastrointestinal

Introduction

Poultry is one of the conventional livestock industries kept throughout the world for meat production and animal protein source. Chickens being part of poultry have been kept since ancient Egypt, China and India. Poultry productions are now on a large scale to feed growing human population because of the increase in food demand (James, 1981; Eekeren *et al.*, 1995).

Problem of poultry production worldwide has been hinged on low productivity, poor genetic status and high mortality due to microbial infestation which stand first in the list. However, less attention has been paid to worm infestation which comprise internal parasites inhibiting hosts' nutritional status by affecting the intake, intestinal absorption, metabolism and excretion of nutrients (Stephenson, 1989).

The chicken, *Gallus gallus*, is an omnivore which often scratch at the soil in search for food items which exposes them to infection of parasite (Adang, 2008; Oniye *et al.*, 2000). Chicken feed on a wide range of diets, a habit that predispose them to parasite infection (Symth, 1976), with many of the parasites serving as intermediate host in chicken that are free ranging (Frantovo, 2000). The gastro intestinal parasites invading

the host possess morphological and physiological features such as small thread like cylindrical body, hooks and hard body cuticle that enhance their adaptation to long living and existence in their host. These parasites constitute a major factor limiting productivity of poultry industries by affecting the growth rate of the host resulting in malfunctioning of organs and eventually death (Soulsby, 1982). Heavy gastrointestinal helminthiasis is characterized by emaciation, mucoid diarrhea, loss of appetite, weakness, paralysis, thickening of gastrointestinal tracts, and death (Fatihu *et al.*, 1991).

The prevalence of Nematodes in caecum e.g *H. gallinarium* could be attributed to developed digestive system, thus given greater chances of establishing a host parasite relationship with *A. galli* (Oyeka, 1989).

In commercial egg production system, the most reported species are *A. galli*, *H. gallinarium* and *Capillaria* spp. However, only few reports have been recorded with the prevalence and significance of helminthes species in commercial production system. Reports have shown that *A. galli* in heavy infection might cause partial or total obstruction of the duodenum or jejunum leading to death, while the adult worm migrate through the lumina of the large intestine, and incorporated into the body (Macklin, 2013).

The objectives of this study were to determine the prevalence of intestinal worm parasites in the domestic fowls in Ijebu-ode, South West Nigeria, identify the probable source of infection in domestic fowl and to suggest possible control measures for intestinal parasites of domestic fowl.

Materials and Methods

Study Area: The study was carried out in Ijebu Ode at the end of the month of December 2015, which coincides with a major festive period.

Ijebu-Ode is situated in the rain forest zone of South-west Nigeria. It is situated between longitudes 6^o49 and 6^o82 and latitudes 3^o55 and 3^o92. It is a town with basic and social infrastructure and heterogeneous population.

Sample Collection and Analysis

This study was carried out during end of the year festival when inhabitants purchase fowl for the festival. The major food item market was visited prior to commencement of the research to intimate the chicken vendors of the purpose of research.

Total samples of 90 gastrointestinal tracts of slaughtered domestic fowls were collected from butchers in the market. The samples collected were intestinal tracts of 15 cockerels, 55 layers and 20 broilers. The tracts were collected separately into different container with 10% formalin and taken to laboratory for parasite screening.

The guts were dissected longitudinally and gentle scrapping of the content of the guts was done to remove the worms embedded in the mucosa layer of various compartments. The contents were examined macroscopically for the adult worm.

The worms found were identified using the methods of Anderson (1992) and Khalil (1994). They were counted before being preserved in 70% ethanol.

Questionnaire was designed to obtain information on farmers' activities in the poultry which include the education status of farmers, frequency of observation of parasites on birds, seasonality of prevalence of parasites and types of local and improved drugs used by the farmers to treat parasitic infections. Results were analyzed in simple percentage.

Results

Forty-one (41) chickens (45.6%) were found to harbour one form of worm or the other. Four helminthic worm species were identified during the examination: *R. echinobothridia*, *C. concorta*, *H. gallinarium* and *A. galli* with prevalence level of 5.8, 9.6, 19.23 and 65.38% respectively (Table 1).

Table 2 showed the distribution pattern of worms according to chicken type, broilers had the least prevalent rate of 40% and the highest prevalent was among the layer 71.4%.

Table 3 showed distribution pattern in relation to worm load that inhabit each type of chicken, broilers had the least prevalent of 11.5% and the layers had the highest worm prevalence of 63.6%.

Forty (40) questionnaires were administered to poultry farmers to determine their level of knowledge about worm infestation in chicken. Twenty (55.6%) reported high prevalence of parasitic worms during the rainy season, 16 (44.4%) of the respondents had observed such during the dry season (Table 4).

Treatments that were claimed to be effective by poultry farmers are indigenous and chemotherapeutic in nature. 25% farmers used *Nicotian tabacum* extract to treat infected birds by adding such to drinking water; 22% used *Carica papaya* extract, 16% had employed *Piper nigrum*, 11% used *Allium sativum* and 3% had employed extract of *Aloe vera* (Table 8). Respondent who employed both indigenous treatment and chemotherapy that came in various trade names had 16.7% using piperazine, 16.7% used febendazole: 8.3% each employed *Allium care* and *leviamisole*, 50% used wormer care to treat worm infestation (Table 6).

Table 1: Prevalence of Intestinal helminthes among slaughtered fowls in Ijebu Ode, Nigeria

Worm type	Class	No of parasite found	%
<i>R. echinobothridia</i>	Cestoda	3	5.8
<i>C. contorta</i>	Nematoda	5	9.6
<i>H. gallinarium</i>	Nematoda	10	19.23
<i>A. galli</i>	Nematoda	34	65.38
Total		52	100%

Table 2: Distribution Pattern of worms according to chicken type in Ijebu Ode, Nigeria

Chicken type	No Examined	No infected	% infected
Broilers	20	8	40
Cockerels	15	8	53.3
Layers	55	25	71.4
Total	90	41	45.6

Table 3: Distribution Pattern of chicken type in relation to worm load in Ijebu Ode, Nigeria

Chicken type	No Examined	Average No of worms found	%
Broilers	20	6	30
Cockerels	15	11	73.3
Layers	55	35	64
Total	90	52	57

Table 4: Frequency pattern of Intestinal helminthes among observed fowls in Ijebu Ode, Nigeria

Season	No of Respondents	%
Rainy	20	55.6
Dry	16	44.4
Total	36	100%

Table 5: Types of indigenous treatment used for treatment of poultry in Ijebu Ode, Nigeria

Months	Frequency	%
Carica papaya	8	22
Nicotian tabacum	9	25
Allium cepa	1	3
Piper nigrum	6	16
Allium sativum	4	11
Azadirachta indica	2	6
Aloe vera	1	3
Neem	5	14
Total	52	100%

Table 6: Respondent using different types of drugs as chemotherapy in addition to indigenous treatment for poultry in Ijebu Ode, Nigeria

Drug	Frequency	%
Piperazine	2	16.7
Fembendazole	2	16.7
Allium care	1	8.3
Lavamisole	1	8.3
Wormer care	6	50.0
Total	12	100%

Discussion and Conclusion

Intestinal helminthes infection among chicken type namely broilers, cockerels, layers were investigated by determining the prevalence, also to know some factors that made poultry birds vulnerable to worm infestation. The results showed that 41(45.6%) of the birds were positive for at least one form of intestinal helminthes infection, which is in contrast to the report of Luka and Ndam (2007) where 62% of 92 birds in Zaria were infected with gastrointestinal parasites.

Three Nematodes and one Cestode were also found in contrast to Luka and Ndam (2007) with the findings of five species each of Cestode and Nematode. *Ascaris* worm was the most prevalent in the birds examined, which is in agreement with the report of Macklin (2013) and Opara *et al.*, (2014); followed by *H gallirannae*. This is however in

contrast to the findings of Ashenafi and Eshetu (2004) where cestode worms were the most prevalent, followed by nematodes.

Broiler had the least infestation of worm 8(40%) probably due to reduced number of months required for its rearing which is between 3-4 months in comparison with cockerels 8(53.3%, layers 25 (71.5%) requiring 6 months and 18-24 months respectively. Also, layers had the highest worm burden 35 (67.3%) followed by Cockerels 15 (21.2%) and broilers 6(11.5%) which conforms to the above as the number of months of rearing determine the worm load as reported by Permin and Hansen (1998).

Exceptionally, the case of layers being the most prevalent in terms of worm infestation and burden may be due to different supplementary additives, both foreign and local. This had been corroborated by Fakae *et al.*, (1991).

Twenty (55.6%) respondents observed parasites mostly during the rainy season. This may be attributed to the fact that such condition is not harsh to infective stage of the worm to infest poultry birds. Sixteen (42%) of the respondents observed worms during the dry season, a reason attributed to the fact that litters get dried up quickly due to high temperature which will not favour the survival of the infective stage of the parasite.

Farmers had resulted into the use of plant extracts as indigenous treatment which was claimed to have been effective by traditional healers as antihelminth in human and animals. 9(25%) had used *N. tabacum*; 8(25%) had used *C. papaya*, 6(16%) used *P. nigrum*, while 3(1%) each had used *A. cepa* and *A. vera*.

Chemotherapy coming in different trade names was not strange to the farmers. 6(50%) administered Worm care, 2(16.7%) each used Piperazine and Fembendazole while 1(8.3%) each used Allium care and Levamisole. This conformed to the report of Darre (2008) where similar drugs were used for the treatment of intestinal worms in poultry. However, the challenges faced in the administration of these drugs were the cost of purchase and eagerness by farmer to get rid of the worms and occasionally administering over dose of the drugs.

Conclusively, it is established that intestinal helminthes infection occurred in poultry farming and efforts must be directed towards prevention and control, treatment of poultry birds; affordable veterinary services should be available to farmers by governmental agencies at little or no cost, it is vital for the government extension services on agriculture be easily accessible to farmers, while a quick response by expert in treatment of poultry should be prompt on receiving calls from farmers who would have noticed signs, symptoms that brings discomfort to poultry.

Practice of high level of hygiene, use of approved germicides, larvicides by farmers at an approved dosage and periodic anti-helminthes treatment should be a routine practice in poultry farms such that farmers can optimally produce poultry birds as source of food and animals' protein to feed the growing population of Nigeria.

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EFFECT OF WRAPPING MATERIALS ON MYCO FLORA GROWTH, PROXIMATE COMPOSITION AND SHELF LIFE OF SOLID PAP SOLD IN LAPAI, NIGER STATE, NIGERIA

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Abstract

*Solid pap a gel-like traditional fermented starchy food produced from maize (*Zea mays*), is a popular food across the various multi-ethnic groups and socio-economic classes in Nigeria. However, packaging, an integral part of food processing that provides the proper environmental conditions for long shelf life and protects the products against microbiological, chemical or physical deterioration is a major problem. This study, therefore investigated the effects of wrapping materials on mycoflora growth, and proximate composition of the food. Proximate and microbial analysis of freshly prepared pap was done before storage for 10 days. The samples were wrapped in banana leaves (*Musa paradisiaca*) and nylon. The proximate and microbial analyses were conducted during storage at day 3, 5 and 10. The results showed that fresh pap have percentage moisture (9.03%), ash (2.08%), crude fibre (3.04%), crude fat (0.85%), protein (3.99%), and carbohydrate (82.00%). The moisture content increased with period of storage from day 0 to 10 day (from 10.03% to 16.50% in leaf and from 10.03% to 12.20% in nylon). The proximate compositions of pap wrapped with nylon were significantly ($p < 0.05$) higher than pap wrapped with leaf except for carbohydrate content which was a bit higher in pap wrapped with leaf than nylon at day 3, 5, and 10 of storage. The isolated fungi in pap included *Mucor* species, *Aspergillus niger*, *A. flavus*, *Penicillium notatum*. The occurrence of these fungi was observed to be significantly ($p > 0.05$) increased from day 3 to day 10, the end of storage period in both wrapping materials. However, this study revealed that the pap is less susceptible to microbial attack, and nutrients are best retained when nylon are used to wrap the pap than leaf. Therefore, the use of banana leaves in wrapping the pap must be discouraged as it made it liable to easy attack by the fungi and invariably leads to its deterioration.*

Keywords: Proximate, Pap, Nylon, Leaf, Mycoflora

Introduction

Solid pap is a gel-like traditional fermented starchy food item produced in Nigeria from maize, millet and sorghum (Plate 1). Its colour depends on the cereal used. It is cream to glossy white from maize, light brown from sorghum and grey to greenish colour from millet. This food had undergone a desirable change due to the action of the invading microorganisms or their metabolic products (Patience, 2013). Solid pap is known by different names in different localities such as eko (Yoruba), akasan (Benin), kamu (Hausa) and agidi (Ibo). It is becoming very popular, with acceptability cutting across the various multi-ethnic groups and socioeconomic classes. The ease of consumption, alone or with soup, stew, beans cake (akara), moi-moi, as light meal especially amongst post operative patients and other patients in the hospitals makes it very popular. (Ogiehor *et al.*, 2005). The traditional production process involves soaking of maize grains in cold water for 1-3 days after which the water is decanted.

The soaked grains are wet milled and sieved and the filtrate is fermented for 2-3 days to yield wet 'ogi', which is sour, white starchy sediment and then boiled into a thick porridge, solid pap (Ujabadeniyi & Adebolu, 2005). The production varies from one locality to another resulting in a non-uniform product, non-specified quality indices, unknown shelf life and lack of safety indices, thus limiting product acceptability to immediate locality. Furthermore, solid pap deteriorates rapidly in storage (2-3 days), warranting repetition of the cumbersome and time consuming production cycles in order to keep product available (Ogiehor *et al.*, 2005).

Packaging is an integral part of food processing. It provides the proper environmental conditions for long shelf life. It protects the products against microbiological, chemical or physical deterioration (Komolafe, 2005). Processed foods can be preserved for extended periods by an aseptic packaging to exclude microbes and oxygen as well as to maintain a moderate temperature (Patience, 2013). However Packaging materials have also been known to be possible source of microbial contamination of this food (Wasiu *et al.*, 2013).

The role of packaging in the food industry which includes protection, containments, transportation, preservation and advertisement are not achieved in all of the packaging method used in Nigeria. This in turn results in a huge loss of the food product not only during packaging processes but also during transportation and sales (Enyisi *et al.*, 2014). The only regulatory body in Nigeria, "National Agency for Food and Drug Administration Control" (NAFDAC) has made tremendous progress in controlling the safety aspect in some of the food industry in Nigeria, such as in the confectionaries, sachet water industry and pharmaceutical industry. However, little or no efforts are made on the local food product which is the most common in the country (Adegunloye *et al.*, 2013).

Solid pap is traditionally wrapped in leaves or transparent polythene bags and marketed. These wrapping materials are poorly handled and transported. They are often dirty and are kept in the open with little or no provision for washing before use. These may therefore be a source of microbial contamination of the food (Adejumo & Ola, 2008).

Over the years few work has been done to try and investigate the effect of the commonly use packaging materials on the nutrient composition and microbial attacked on pap as a general local food especially in Niger State particular in Lapai.

The aim of this study was to investigate the effect of some wrapping materials on mycoflora growth, shelf life and proximate composition of solid pap sold in Lapai, Niger state Nigeria. The result will be used to establish the best hygienic wrapping materials for solid pap.

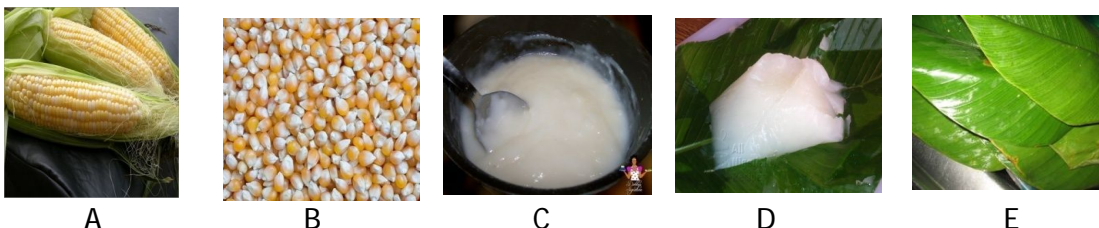


PLATE 1: A. Maize cob B. Maize grain C. prepared pap D. Pap E. wrapping leaves wrapped with leaves

Source: (<http://www.coextra.eu/images/image1233.html>)

Materials and Methods

Collection of Materials

Matured wholesome, disease free maize (*Zea mays*) grains, banana leaves and nylon (Plate 1) were bought from market in Lapai Niger State, Nigeria between June and July 2014.

Traditional Preparation of Pap

Three kg of maize grains were steeped in 6L of distilled water for 2 days at room temperature. The steep water was decanted and grain washed in fresh distilled water followed by wet milling and wet sieving through 450µm sieve screen. The resulting fines grains from traditional and modified process were allowed to settle and ferment (24hrs) to slurries and the sediment was used to prepare the pap using hot water to simulate the traditional preparation (Oyarekua & Eleyinmi, 2004). A mole of pap was made by using beaker to dispense 25cm³ of maize paste on the leaf or nylon and wrapped immediately. 20moles of leaf wrapped pap and 20 moles of nylon wrapped pap were made. All samples were stored under ambient temperature for 10 days in the Biological Sciences laboratory Ibrahim Badamasi Babangida University, Lapai. Proximate composition of the pap and microbial growth were monitored at day 3, 5 and 10 of storage.

Proximate Analysis

Determination of Moisture Content

Two gram of the sample was placed in the crucible and heated at 105°C until a constant weight was attained. The moisture content was calculated as loss in weight of the original sample and expressed as percentage moisture content (A.O.A.C., 2005).

$$\% \text{ Moisture} = \frac{(W2 - W3)}{(W2 - W1)}$$

Where: W1 = weight of empty crucible
W2 = weight of crucible + sample before drying
W3 = final weight of crucible + sample after drying

Determination of Crude Protein

The sample (0.5g) was digested with 5ml of concentrated sulphuric acid in the presence of Kjeldahl catalyst. The nitrogen from the protein in the sample was converted to ammonium sulphate that reacted with 2.5ml of 2.5 % Brucine reagent, 5ml of 98 % sulphuric acid to give a coloured derivative and the absorbance read at 470nm. The percentage nitrogen is calculated and multiplied by 6.25 to obtain the value of the crude protein (A.O.A.C., 2005).

$$\% \text{ Nitrogen} = \frac{(Vs - Vb \times N_{acid} \times 0.01401)}{W} \times 100$$

Where: Vs = titre value of the sample
Vb = acid required to titrate
N acid = normality of acid
W = weight of sample in grams

Estimation of Crude Lipid

This estimation was performed using the Soxhlet extraction method of AOAC, (2005). Ten (10)g of the sample was weighed and wrapped with a No 1 Whatman filter paper and placed in a thimble. The thimble was covered with cotton wool and placed in the extraction column that was connected to a condenser. Two hundred (200) ml of n – Hexane was used to extract the lipid.

$$\% \text{ Fat} = \frac{(W2 - W3)}{(\text{Weight of sample})} \times 10$$

Where: W₂ = wt of filter paper and sample before extraction

W_3 = wt of filter paper and sample after extraction

Determination of Crude Fibre

Five (5)g of the sample and 200ml of 1.25 % H_2SO_4 was heated for 30minutes and filtered with a Buchner funnel. The residue was washed with distilled water until it was acid free. Two hundred (200)ml of 1.25% NaOH was used to boil the residue for 30minutes, and it was filtered and washed several times with distilled water until it was alkaline free. It was then rinsed once with 10% HCl and twice with ethanol. Finally, it was rinsed with petroleum ether three times. The residue was put in a crucible and dried at 105°C in an oven overnight. After cooling in desiccators, it was then ignited in a muffle furnace at 550°C for 90 minutes to obtain the weight of the ash.

% fibre content = the loss in weight after incineration $\times 100$.

Determination of Ash Content

The ash content of the sample was determined using AOAC standard method (2005). Five (5)g of the sample was weighed into a crucible of known weight and was dried in an oven for about 4hrs at 105°C. The sample in the crucible was ashed in a muffle furnace at 500°C, until white was obtained. It was allowed to cooled in a desiccators and was then reweighed.

%Ash content = $(w_3 - w_1)/(w_2 - w_1) \times 100$

Where: W_1 = weight of empty crucible

W_2 = weigh of sample + weigh of crucible before aching

W_3 = weigh of sample + weigh of crucible after aching.

Carbohydrate Determination

The carbohydrate content was determined by subtracting the summed up percentage compositions of moisture, protein, lipid, fibre, and ash contents from 100% (Otitaju, 2009).

%Carbohydrate = $100 - (\%Protein + \%Moisture + \%Ash + \%Fibre)$

Isolation of Fungi

Serial dilution technique was used, one gram of each samples was crushed and aseptically transferred into 9ml of sterile distilled water in test tubes. It was then shaken properly to allow for even distribution of microorganisms present in the sample. The dilution factors 10^{-1} and 10^{-2} were used as stock solution. One (1) ml of each dilution was aseptically taken from the suspension and transferred into sterile Petri dishes. Ten (10) ml of Potato Dextrose Agar (PDA) was poured into the Petri dish with 1ml of chloramphenicol. The plates were swirled gently to allow even distribution of the sample. Incubation was done at room temperature $28 \pm 2^\circ C$ for 24 hours. Subcultures were made from the mixed cultures. Fungal isolates were identified using fungal family of the World Mycological Monographs (Cannon & Kirk, 2007; Amadi & Adebola, 2008).

Statistical Analysis

The experimental data generated at days 3, 5 and 10 of storage were statistically analyzed using Analysis of variance (ANOVA) using completely randomized design of SPSS statistical package computer software (2009 version), Turkey's test of the same package was used to compare the significant ($p < 0.05$) differences among individual.

Results

Proximate composition of fresh pap

The results of the percentage proximate composition of the cold pap are presented in Table 1. The fresh pap at day 0 was found to contain 9.03 ± 0.04 % moisture content, ash 2.08 ± 0.01 %, crude fat 0.85 ± 0.05 %, crude fibre 3.04 ± 0.01 %, crude protein 3.99 ± 0.01 % and carbohydrate 82.00 ± 0.01 %. The proximate composition of pap wrapped in banana leaf and nylon decreased continuously from days 3, 5 to day 10 of storage. The protein content was found to significantly decreased from day 0 to day 10 (from 3.99 ± 0.01 % to 2.35 ± 0.11 % and 3.05 ± 0.12 % in leaf and nylon respectively). However, there was no significant difference ($p < 0.05$) in the decrease observed in nylon as with the leaf. The moisture content increased with period of storage from day 0 to 10 day. That was from 9.03 ± 0.04 % to 16.50 ± 0.21 % in leaf and from 9.03 ± 0.04 % to 12.20 ± 0.6 % in nylon. The increase in moisture content was significantly different ($P < 0.05$) in leaf while in nylon, there was no significantly different ($P < 0.05$) between days 5 and 10. The Carbohydrate content at day 0 (82.00 ± 0.01 %) was significantly higher ($P < 0.05$) than the other storage days and decreased to 79.12 ± 0.01 % and 79.81 ± 0.9 % at day 10 in leaf and nylon respectively. The decrease was not significantly different ($P < 0.05$) between days 3, 5 and 10 of storage in both the leaf and nylon. The crude fat was generally low compared to other food constituents. It was 0.85 ± 0.05 % at day 0 and decreased to 0.74 ± 0.22 % and 0.80 ± 0.33 % in leaf and nylon respectively. However, there was no significantly difference ($p < 0.05$) between days 0, 3, 5 and 10 in both leaf and nylon. This trend was also observed in crude fibre.

Table 1: Percentage Proximate composition of stored pap wrapped in leaf and nylon at day 0, 3, 5 and 10 of storage

Fungi isolated	Control (%)	Pap wrapped with leaf (%)			Pap wrapped with nylon (%)		
	Day 0	Day 3	Day 5	Day 10	Day 3	Day 5	Day 10
Moisture content	9.03 ± 0.04^a	12.70 ± 0.01^b	14.68 ± 0.01^c	16.50 ± 0.21^d	12.20 ± 0.0^b	12.05 ± 0.01^c	12.20 ± 0.61^c
Ash content	2.08 ± 0.01^a	0.81 ± 0.04^b	0.80 ± 0.01^b	0.78 ± 0.11^c	2.00 ± 0.01^b	1.49 ± 0.05^b	1.35 ± 0.01^c
Crude fat	0.85 ± 0.05^a	0.79 ± 0.10^b	0.75 ± 0.11^c	0.74 ± 0.22^c	0.83 ± 0.00^a	0.83 ± 0.01^a	0.80 ± 0.33^a
Crude fibre	3.04 ± 0.01^a	2.71 ± 0.01^b	2.70 ± 0.03^b	2.61 ± 0.21^c	3.03 ± 0.01^a	3.03 ± 0.11^a	3.02 ± 0.91^b
Crude protein	3.99 ± 0.01^a	3.08 ± 0.23^b	3.02 ± 0.77^b	2.35 ± 0.11^c	3.10 ± 0.21^a	3.08 ± 0.06^a	3.05 ± 0.12^c
Carbohydrate	82.00 ± 0.01^a	81.91 ± 0.01^b	80.05 ± 0.00^b	79.12 ± 0.01^b	80.11 ± 0.11^b	80.11 ± 0.11^b	79.81 ± 0.9^b

Values follows by the same superscript in same treatment and row compared with control are not differ significantly at $p < 0.05$, values are Mean \pm SEM of triplicate determination.

Fungal Contamination

A total of four fungi species (*Mucor* species, *Aspergillus niger*, *A. flavus*, *Penicillium notatum*) from three genera were isolated (Table 2). The incidence of fungal contamination started from day 0 (freshly prepared pap). At this period the *Mucor* sp. has the highest population (2.00 ± 1.99) of occurrence, while *P. notatum* was the least (0.28 ± 0.12 %). Generally speaking, the occurrence of the fungi isolated was higher in pap wrapped with banana leaves throughout the period of storage. The occurrence of these fungi was observed to be significantly ($p > 0.05$) increased from day 3 to day 10, the end of storage period in both wrapping materials. At the end of storage period *A. flavus* has the highest occurrence from 0.86 ± 0.35 in day 0 to 64.94 ± 2.0 in day 10 followed by *A. niger* 1.86 ± 1.90 day 0 to 62.05 ± 1.70 % at day 10 in pap wrapped with leaves, while *P. notatum* has the highest occurrence (31.25 ± 0.11) followed by *A.*

niger (28.75±1.09) in pap wrapped with nylon. However, by the end of storage period, the occurrence of *Mucor* sp. was the least in both wrapping materials.

Table 2: Fungal population in pap samples on the day 0, 3, 5 and 10 using different wrappers

Fungi isolated	Control (%)	Pap wrapped with leaf (%)				Pap wrapped with nylon (%)		
	Day 0	Day 3	Day 5	Day 10	Day 3	Day 5	Day 10	
Aspergillus flavus	0.86±0.35 ^a	26.13±1.70 ^b	43.48±2.00 ^c	64.94±2.00 ^a	23.08±1.03 ^b	11.80±0.33 ^c	24.38±1.03 ^a	
Aspergillus niger	1.86±1.90 ^a	26.13±1.70 ^b	50.87±1.70 ^a	62.05±1.70 ^a	25.38±1.09 ^b	18.18±1.20 ^c	28.75±1.09 ^b	
Penicillium notatum	0.28±0.12 ^a	22.36±0.33 ^a	32.61±0.13 ^a	44.58±0.13 ^c	20.00±0.11 ^c	15.45±0.00 ^b	31.25±0.11 ^a	
Mucor species	2.00±1.99 ^a	7.90±2.74 ^b	23.04±0.74 ^b	38.43±0.74 ^a	11.54±1.22 ^a	14.55±1.85 ^a	15.62±1.22 ^c	

Values follows by the same superscript in same treatment and row compared with control are not differ significantly at $p < 0.05$, values are Mean \pm SEM of triplicate determination.

Discussion

The present study revealed the nutritional composition of solid pap and how they are affected by different types of wrapping materials.

Packaging is an integral part of food processing, it provides the proper environmental conditions for long shelf life. This was in evidence from the results obtained from cold pap wrapped with two different materials (nylon and banana leaf) and stored for the period of ten days.

The results of the proximate composition before and after storage period showed that cold pap contain crude fat, crude fibre, crude protein, carbohydrate and ash as earlier reported by Enyisi *et al.*, (2014) in maize grain and maize products. Pikuila and Ilelaboye, (2013) and Oyarekua and Eleyinmi, (2004) also made similar reports on the proximate and chemical composition of 'ogi' prepared from maize grain. However, the modification of traditional process of maize to 'ogi' and then to pap have been reported to significantly affect their proximate composition (Oyarekua & Eleyinmi, 2004).

The results on the moisture content revealed that moisture content which was at minimal percent at day 0 is an indication of stable self life if properly packaged and stored, because low moisture is necessary in food for good keeping quality and longer shelf life (Amadi & Adebola, 2008). The moisture increased with the period of storage in both wrapping materials. However, the moisture content of pap wrapped with leaves was found to be on the high side before the end of storage period probably due to high porosity of the leaf which may allow seepage of moisture from the environment thus triggering the activities of micro-organisms. This might be disadvantageous to the shelf life of pap as lower moisture content is important for long storage by maintaining fungal contamination and spoilage (Enyisi *et al.*, 2014).

Moisture content is also an index of water activity and is used as a measure of the stability and susceptibility to microbial contamination. The high moisture content in pap wrapped with leaves showed that it might have short shelf life (Okerulu *et al.*, 2015). Jonathan *et al.* (2010) also reported an increase in moisture content of stored onion from one month to 12 months and attributed it to probably high humidity of the

environment where onion was stored. Nylon wrapper could maintain the moisture level of the pap from initial 10.03 ± 0.04 to 12.05 ± 0.061 at the end of day 10. However, the loss of nutrients is more pronounced in solid pap wrapped with banana leaf when compared with pap wrapped with nylon. Probably because nylon is much less permeable to water vapour and gases than leaves and are chemically inactive with food (Adejumo & Ola, 2008) and thus prevent absorption of moisture from the environment by the pap.

The ash content was found to be generally low probably due to leaching of soluble inorganic salts during steeping, fermentation and disposal of steep water prior to milling as reported by Oyarekua and Eleyinmi (2004). The ash reduced from day 0 from 2.08 ± 0.01 to 0.78 ± 0.011 in pap wrapped with leaf and 1.35 ± 0.01 in nylon. But this finding was not in agreement with Faleye *et al.*, (2012) who reported increase in ash content of stored food and attributed it to probably the condiments added. But agreed with findings of Fagbohun (2012) who reported depletion in ash content of non-infected cocoa seed during storage. Aziz *et al.*, (2000) also reported that *Aspergillus flavus* depleted zinc and iron from infected crushed corn. Also, Pikuda and Ilelaboye, (2013) reported reduction in ash content of 'ogi' probably due to the large surface area of the substrate which hasten leaching of minerals into steep water during processing.

The crude fat composition was also found to decrease with period of storage. The decrease in nylon wrapped pap was not as high as pap wrapped with leaves. Probably the decrease might be because of fungi infestation that produced enzyme lipase which hydrolyzed the fat for their use (Braid *et al.*, 2012). But this agreed with Onifade and Jeff-Agboola (2003) who reported the decrease in fat content of stored infected *Cocos nucifera*.

There was no significant change in crude fiber of pap wrapped in nylon between day 0 up to day 10 of storage but significantly different from pap wrapped with leaves. The slight reduction may be due to enzymatic degradation of the fibrous material during storage as reported by Oyarekua and Eleyinmi (2004). The initial value of the fiber content obtained from freshly prepared pap at day 0 agreed with report of Ujabadenyi and Adebolu (2005).

Crude protein content at day 0 (4.99 ± 0.01) was comparable with 4.12, 5.93%, 4.8% and 5.4% values reported by Oyarekua and Eleyinmi (2004). The decrease with the days of storage may probably be as a result of the microbial attack which might secret enzymes to hydrolyse the protein for their use as reported by Braide *et al.* (2012). The finding was not in agreement with Pikuda *et al.* (2000) who reported an increase in protein content of samples on which fungi grow and that the increase could be from slight protein synthesis by proliferation of micro-organisms and synthesized enzyme protein. However, the protein content of nylon wrapped pap was higher than that of leaf at the end of storage.

Carbohydrate content of the pap was slightly decreased in both wrapping materials from day 0 to day 10. The initial high carbohydrate content at day 0 was higher than 65.63% to 70.23% reported by Ujabadenyi and Adebolu (2005). The little reduction may be due to the fact that the carbohydrate was used for metabolic activities during storage (Jonathan *et al.*, 2010). The processing operations involving steaming, fermentation and pressure cooking may increase the digestibility of starch, rendering it

more susceptible to enzymatic digestion and hence the reduction (Oyarekua & Eleyinmi, 2004).

It is well known that fungi may cause a lot of deterioration and thus constitute hazards to the life of animals and man. The fungi isolated from stored pap in this study include the mesophilic fungi; *Aspergillus flavus*, *Aspergillus niger*, *Penicillium notatum* and thermophilic fungi; *Mucor* species. They have been implicated in the deterioration of food substances by the earlier reports of Amadi and Adebola (2008), Fadunsi *et al.* (2011), Braide *et al.* (2012), Faleye *et al.* (2012) and Jonathan *et al.* (2010). These four fungi were isolated right from day 0, meaning that the pap has been contaminated by the spores of these fungi probably during processing from air or utensils used (Abbey, 2007). The occurrence of the fungi was observed to increase with days of storage probably because of the increase in moisture content and digested food substances which support the growth.

The results showed that the pap wrapped in nylon was safe for consumption than leaves even after day 10 of storage with little deterioration. Therefore, the use of leaves to wrapped pap should not be encouraged because it encourages fungi growth that in turn may produce aflatoxin which are secondary metabolites that are highly mutagenic and toxic for human and also animal as earlier reported in bean pudding, pounded yam and pap wrapped with *Banana* leaves by Adegunloye *et al.*, (2012).

Conclusion

In this study, the extensive microbial growth and the associated activities led to the decrease or increase observed in the proximate content of the pap during the period of storage. However, it was observed that these nutrients were best retained when nylon was used in wrapping the pap and also made the pap less susceptible to microbial attacked. Therefore, the use of banana leaves in wrapping the pap must be discouraged as it led to its quick deterioration.

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GROUNDWATER EXPLORATION AT THE SOUTH-WESTERN PART OF
MAIKUNLKELE VILLAGE, NIGER STATE NIGERIA, USING
ELECTRICAL METHOD

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Abstract

A conventional D.C Vertical Electrical Sounding (VES) Survey was carried out in Government Day Secondary School Site, Maikunkele Minna, Nigeria. It lies between latitudes 09°40'37.17" to 09°41'37. 15"N and longitudes 06°29'51.66" to 06°30'51.55"E in the Basement complex region of Nigeria. The survey was carried out with the aim of determining the ground water potential of the area, the technique employed in this study is the Vertical Electrical Sounding (VES) using Schlumberger configuration. A total of 30 vertical electrical sounding (VES) points were located on grid profiles separated at 100 m interval between profiles. The data obtained from the field were subjected to geophysical interpretation with the help of a computer based program called WinResist software. Result from both the iso-resistivity plots and the vertical sections indicate three geological sections which are the topsoil whose resistivity ranges from 10 Ω m to about 400 Ω mat various depths from 0 m to 1 m the second layer are laterite in some places such as profiles C, D and E and weathered /fractured basement on profiles A and B its depth extend to about 10 meters in most cases, with resistivity below 500 Ω m. The third layer which is fresh basement on profiles A and B and parts of C is majorly weathered basement on profiles D, E and some parts of C. the result of this investigation reveals that points located within profiles D and E falls within weathered basement to a depth of about 30 meters and can be recommended for any bore hole drilling for efficient fresh water production.

Keyword: *Lithology, Aquifer, Geoelectric, Basement, Vertical Electrical Sounding (VES)*

Introduction

More than 300 million people in Africa today do not have access to clean water (Water for Africa, 2010). Many communities meet their daily water need from rivers, lakes, or reservoirs, sometimes using aqueducts or canals to bring water from distant surface water sources (Plummer *et al.*, 1999; Water for Africa, 2010). Another important and more improved source is groundwater, the water that lies beneath the ground surface, filling the pore space between grains in bodies of sediment and clastic sedimentary rock, and filling cracks and crevices in all types of rock. The source of groundwater is rain and snow that falls to the ground. A portion of this precipitation percolates down into the ground to become groundwater. How much precipitation soaks into the ground is influenced by climate, land slope, soil and rock type, and vegetation. In general, approximately 15% of total precipitation ends up as groundwater, but that varies locally and regionally from 1 to 20%. Despite the fact that global water distribution shows that groundwater is about 0.61%, it is surprisingly, about 60 times as plentiful as fresh water in lakes and rivers on the surface (Plummer *et al.*, 1999; Water for Africa, 2010).

Groundwater is therefore, a tremendous major economic resource, particularly in most cities of Nigeria where portable water is scarce. Many homes and organizations pump their required quantities of water from the ground because groundwater is commonly

less polluted and more economical to use than surface water (Plummer *et al.*, 1999). Electrical resistivity survey is relevant to groundwater exploration (Olasehinde, 1999; Nwankwo *et al.*, 2004; Singh *et al.*, 2006; Alile *et al.*, 2008; Ariyo & Adeyemi, 2009; Anudu, *et al.*, 2011; Oyedele *et al.*, 2011). The resistivity of rocks is strongly influenced by the presence of groundwater, which acts as an electrolyte. The minerals that form the matrix of a rock are generally good resistors than groundwater, so the resistivity of sediment decreases with the amount of groundwater it contains. This depends on the fraction of the rock that consists of pore spaces and the fraction of this pore volume that is water filled (Lowrie, 1997).

Among the geoelectrical methods, vertical electrical sounding techniques have been frequently used in hydrogeophysical studies for groundwater in both porous and fissured media (Onuoha & Mbazi, 1988; Mbonu *et al.*, 1991; Franjo *et al.*, 2003). This method is based on the response of the earth to the flow of regulated input dc current source. The VES method was chosen for Maikunkele study area because it has proven to be an economic, quick and effective means of solving most ground water problems in different parts of the world (Brusse, 1963, Zohdy & Jackson, 1969; Frohlich, 1974). This study is to investigate the subsurface hydrogeological conditions and to assess the ground water potentials of the area. The main objectives are to delineate probable confined and unconfined aquifers that could be developed into productive boreholes. This will entail the estimation of geoelectric parameters (layer thickness and resistivities) from field geoelectrical measurements. The results from these would then be used to draw conclusion to locate the possible sites within the study area where ground water development could be better sited.

Statement of the Problem

Meeting the growing demand of easy access to potable water which is inadequate in the study area because due to inadequate distribution systems. The problem of obtaining adequate supply of quality water is generally becoming more acute in the study area due to ever increasing population and industrialization.

Location and Accessibility of the Study Area

The study area Government Day Secondary School site is located between latitudes $09^{\circ}40'37.17''$ to $09^{\circ}41'37.15''$ N and longitudes $06^{\circ}29'51.66''$ to $06^{\circ}30'51.55''$ E (Figure 1.1). The area lies within the south western part of Minna metropolis and is accessible through Minna-Zungeru-Kontagora road. The area has a typical Guinea savannah climate with distinct wet and dry seasons: A dry season which usually last from December to March and an accompanied rainy season which last from April to October.

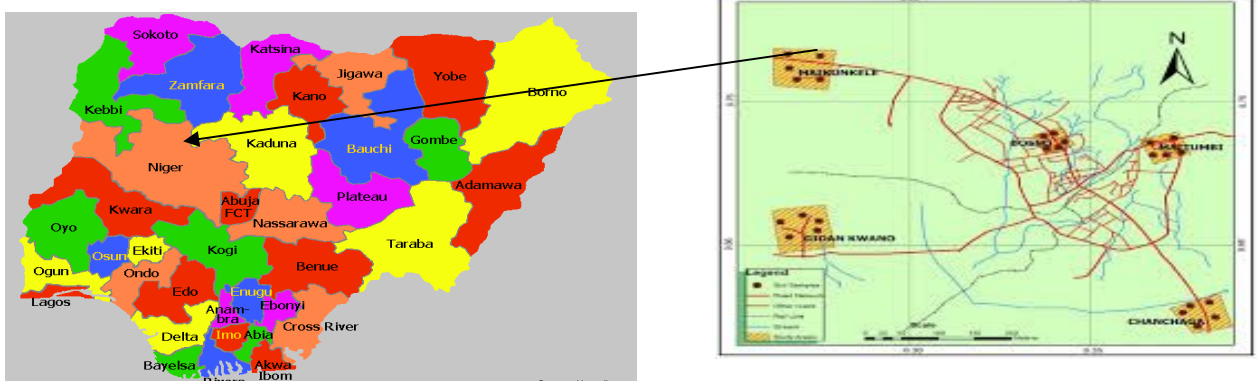


Figure 1: Location Map of the Study Area

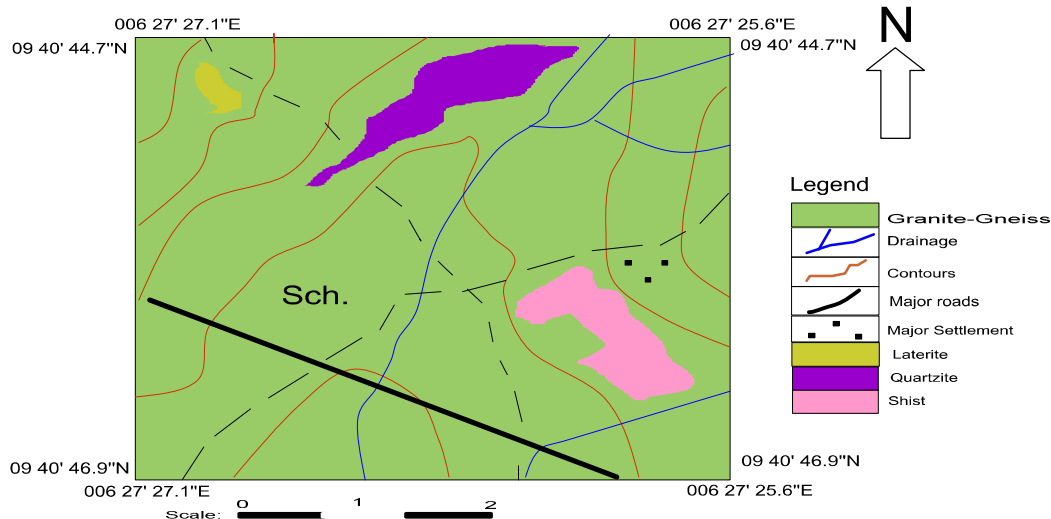


Figure 2: Geological Map of the Study Area

The geology of the study area is part of Minna Sheet 164 and falls within the Basement Complex Terrain of Nigeria. The Nigerian Basement Complex forms part of the ancient African shield, bordered to the west by West African Cratonic Plate and underlies about 61% of Nigeria's land mass. The rock types found in the study area consists redominantly of coarse-grained biotite granite and granodiorite. The granite types and the granodiorite together form part of the older Granite. The geology of the study area is part of Minna Sheet 164 and falls within the Basement Complex Terrain of Nigeria. The Nigerian Basement Complex forms part of the ancient African shield, bordered to the west by West African Cratonic Plate and underlies about 61% of Nigeria's land mass. The rock types found in the study area consists predominantly of coarse-grained biotite granite and granodiorite. The granite types and the granodiorite together form part of the older Granite. The study area is underlain by Precambrian rocks of the Nigerian basement complex and consists of crystalline rocks mainly of older granite series formed during the Pan Africa Orogeny. The older granite consisting pagmatites, quartz veins, porphric granites, gneisses are present. The hydrogeology of the study area is controlled by the vegetation rainfall, vegetation cover and evapotranspiration and the general geology of the area. The geology of the area serves as the ground water reservoir while rainfall is the dominant source of the ground water. These factors are responsible for the number of aquifers to be encountered and the means of recharging them.

Methodology

The procedure employed in this research is as follows:

- i. Profile laying
- ii. data collection
- iii. data analysis
- iv. interpretations
- v. and conclusions

Geotron terrameter with model number 41 was used throughout to collect both current and voltage readings which were later converted to resistance values with the help of Ohm's law ($R = V/I$). The resistance value multiplied by the geometric factor (K-factor) gives the resistivity.

VES points D1 to D6 made up of profile D and VES points E1 to E6 made up of profile E. In order to accurately locate the VES points even after the field survey, GPS was used to collect the coordinate and topography readings for each VES point.

Finally, the terrameter was set up by inserting both the current and potential electrode into the ground while ensuring tight connections of the terminal.

Data Collection

The study area was gridded as shown in Figure 3.1, the survey area was covered by five (5) profiles and each profile was 500 m long. The inter grid spacing and that of inter-profile spacing was 100 m apart respectively. The terrameter model Geotron 41 was used to collect data for about Thirty (30) VES points using the Global Positioning System (GPS) to locate the sounding points appropriately. The Schlumberger configuration method was used in taking the data. This array is the most widely used of all other configuration in vertical probing.

Data Presentation

Ohm's law ($R = \frac{V}{I}$) was used to estimate the resistance and later multiplied by the geometric factor to obtain the apparent resistivity, the apparent resistivity data obtained from the VES survey was presented as depth sounding curves by plotting the apparent resistivity along the ordinate axis and the half current electrode spacing (AB/2) along the abscissa. The plot was made on log-log graph paper. The resistivity depth sounding curves was classified based on layer resistivity, the number of layers in the subsurface and the thickness of each layer.

Theory of Electrical Resistivity Method

The fundamental equation for resistivity survey is derived from Ohm's law (Grant and West, 1965; Dobrin and Savit, 1988; Nwankwo, 2010):

$$\rho = \frac{RA}{L} \tag{1}$$

Where ρ is resistivity, R is resistance, L is length of homogenous conducting cylinder and A is cross sectional area for the solid earth, whose material is predominantly made up of silicates and basically non-conductors, the presence of water in the pore spaces of the soil and in the rock fractures enhances the conductivity of the earth when an electrical current I is passed through it, thus making the rock a semi-conductor. Since the earth is not like a straight wire and it is anisotropic, then equation (1) is thus customized to:

$$\rho = \frac{AV}{I} \cdot 2\pi r \tag{2}$$

Where $2\pi r$ is then defined as a geometrical factor (G) fixed for a given electrode configuration.

The Schlumberger configuration was used in this work. The geometric factor G is thus given as

$$\rho_a = \frac{AV}{I} \cdot 2\pi r \tag{3}$$

Wenner array. Electrical resistivity profiling is usually carried out when variation in apparent resistivity in horizontal direction is to be determined (Telford *et al.*, 1980), if boundaries or discontinuities are vertical rather than horizontal. However, the length of the electrode configuration or electrode spacing is very important because it determines the depth of penetration. For each position of the electrode, an apparent resistivity is obtained and the resulting data is contoured that is joining area of equal apparent resistivity with a line. The method is particularly applicable to location of high and low resistivity surface materials. This technique can be used for fractures,

topographic peaks, ore bodies, gravel deposits and water. Wenner array. Electrical resistivity profiling is usually carried out when variation in apparent resistivity in horizontal direction is to be determined (Telford *et al.*, 1980). However, the length of the electrode configuration or electrode spacing is very important because it determines the depth of penetration. For each position of the electrode, an apparent resistivity is obtained and the resulting data is contoured.

Vertical Electrical Sounding

Electrical resistivity sounding is used when an investigation of resistivity variation with depth is being carried out. This method helps in determining apparent variation in resistivity with depth that is, vertical changes in apparent resistivity in the earth when the subsurface of different geo-electrical layers are detected horizontally. It may be different vertically. Apparent resistivity method furnishes details on the vertical succession of the conducting zones and the individual thickness and true resistivity. The technique is based upon the fact that the fraction of the electric current put into the ground, penetrating below any particular depth, increase with increased penetration of the current. The electrode configuration commonly used for vertical electrical sounding (VES) is the Schlumberger array. For this survey, the Schlumberger array method was employed. The value of the apparent resistivity depends on the geometry of the electrode array used (G factor).

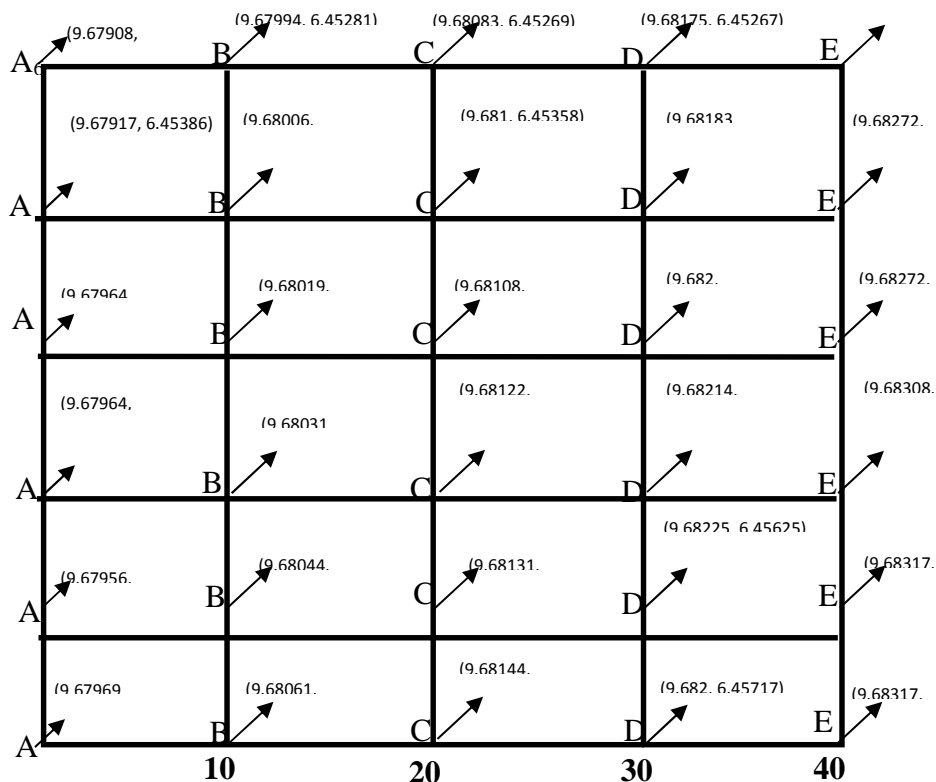


Figure 3: The Profile Layout for VES Data Collection N-S (North-South)

$$AB \geq 5 \quad MN \rho_a = \pi K \frac{V}{I} \times \left[\frac{\left(\frac{AB}{2}\right)^2 - \left(\frac{MN}{2}\right)^2}{MN} \right]$$

This array is less sensitive to lateral variations and faster to use as only the current electrodes are moved.

Data Analysis and Interpretation

Ohm's law $V = IR$ was used to estimate the resistance value and later multiplied by the geometric factor to obtain the apparent resistivity.

The VES interpretation was carried out using a computer program, called WinResist software 2010 edition. The curve gives the equivalent n-layered model from the apparent resistivity of each sounding point. Surfer 10 computer software was used to produce iso-resistivity and geoelectric vertical section contour maps of data deduced from the WinResist. This gives more information about the sub-surface structure.

Interpretation of Iso-resistivity

From the results obtained from WinResist software curves, which is continuous variation of resistivity with depth, the following interpretations were deduced.

- i. The Iso-resistivity Maps at varying depths: 0 m, 5 m, 10 m, 15 m, 20 m, were produced.
- ii. contour map of Geo-electric section through the profiles and

The geo-electric section and geologic interpretation was based on all available geologic information found within the study area. The resistivity values were later compared with standard values of resistivity associated with rock types in the basement complex and this is to ascertain the composition and the geo-sections in the study area.

Interpretation of Iso-resistivity Contour Map at Surface

The Iso-resistivity Map at surface is as shown in Figure 4, produced from values on table 1a. The map is contoured at interval of 20 Ωm . The resistivity varies from 20 Ωm to 460 Ωm . The high resistivity observed around VES D2 can be attributed to human activity as evidence on the site, which shows outcrops concrete during construction of the school compound. It can be observed that at the extreme Northern corner of the study area that there exists an outcrop of weathered granitic-gneiss rock. A low resistivity region observed at the central portion of the study area is a region where the top soil has washed away revealing a sandy region which has high permeability. Other region generally shows low to high resistivity of top soil.

Interpretation of Iso-resistivity Contour Map at 5m

The Iso-resistivity Map at surface is as shown in Figure 5, produced from values on table 1a. The map is contoured at interval of 50 Ωm . The resistivity varies from 20 Ωm to 460 Ωm . The resistivity value of 50 Ωm to 200 Ωm could be observed at central, north eastern, south-eastern and north- western part, this zone may likely show clay saturated with surface water. The fractured or fairly weathered basement could be found prominently at south-eastern part of the map (i.e. VES C4 and D5) with resistivity value ranging between 50 Ωm and 150 Ωm . A high resistivity value of 600 Ωm was found prominent at south-western corner of the study area (i.e. VES B1) which is also found at the surface. This signifies a weathered basement rock.

Interpretation of Iso-resistivity Contour Map at 10 m

The Iso-resistivity Map at 10 m depth is as shown in figure (6) produced from values on table 1b. The map is contoured at interval of 30 Ωm . The resistivity varies from 60 Ωm to

960 Ωm across the field. The relatively high resistivity value observed at the south western part of the study area is due to the lateritic content, a low resistivity region at the North-eastern part of the study area. This region has resistivity value ranging between 30 Ωm to 150 Ωm which could be attributed to weathered basement table1b. The fractured or fairly weathered basement could be found prominently at south-western part of the map (i.e. VES B1) with resistivity value ranging between 240 Ωm and 460 Ωm .

Interpretation of Iso-resistivity Contour Map at 20 m

The map of iso_resistivity at 20 m (figure 7) produced from values on table 1b is contoured at interval of 50 Ωm . The resistivity varies from 50 Ωm to 750 Ωm . It can be observed here that the relatively high resistance found at the south western part, also continued at the central part of (Figure 7) and South-Western part of the iso- resistivity map at 20 m. This is an indication that the laterite extends down at a much longer depth and at the Northern corner of the study area (VES D3). This region has resistivity value ranging between 200 Ωm to 500 Ωm and it can be seen that the region has a low resistivity at the northern part of the study area with resistivity value ranging between 30 Ωm to 150 Ωm . This is attributed to presence of ground water.

		surface		5 meters	
X	Y	RES	Y	RES	
0	0	38.3	0		
100	0	3.4	0	1058	
200	0	1.6	0		
300	0	56.6	0	56.6	
400	0	3.8	0		
500	0	365.9	0	365.9	
0	100	179.7	100	179.7	
100	100	45	100	45	
200	100	281.3	100	281.3	
300	100	161.2	100		
400	100	94.8	100	16	
500	100	127.7	100		
0	200	54.9	200	354.5	
100	200	92.5	200		
200	200	47.2	200		
300	200	10	200		
400	200	91.1	200	91.1	
500	200	10.3	200		
0	300	216.4	300	70	
100	300	101.8	300	101.8	
200	300	230.1	300	323.1	
300	300	2.1	300		
400	300	457.2	300	24.9	
500	300	18.6	300	18.6	
0	400	393.1	400	393.1	
100	400	147.3	400	147.2	
200	400	124.3	400	124.3	
300	400	38.5	400		
400	400	1.5	400	3.3	
500	400	157.6	400		

Table 1b: iso-resistivity values for 10 and 15m

10 meters			20 meters		
X	Y	RES	X	Y	RES
0	0		0	0	89.1072
100	0	40.241	100	0	25.169
200	0	552.57	200	0	78.131
300	0	91.284	300	0	92.042
400	0	49.189	400	0	45.21
500	0		500	0	65.607
0	100		0	100	175.404
100	100	108.46	100	100	112.455
200	100		200	100	40.2
300	100		300	100	52.472
400	100	10.472	400	100	74.682
500	100	7.14	500	100	43.633
0	200		0	200	723.69
100	200	163.36	100	200	185.377
200	200	685.92	200	200	435.336
300	200		300	200	227.528
400	200		400	200	269.28
500	200	76.507	500	200	84.2996
0	300		0	300	225.968
100	300	176.45	100	300	136.45
200	300		200	300	465.349
300	300	19.074	300	300	6.542
400	300	247.63	400	300	558.756
500	300		500	300	79.036
0	400		0	400	33.505
100	400		100	400	249.046
200	400	182.04	200	400	220.34
300	400		300	400	99.199
400	400	140.16	400	400	199.08
500	400		500	400	120.76

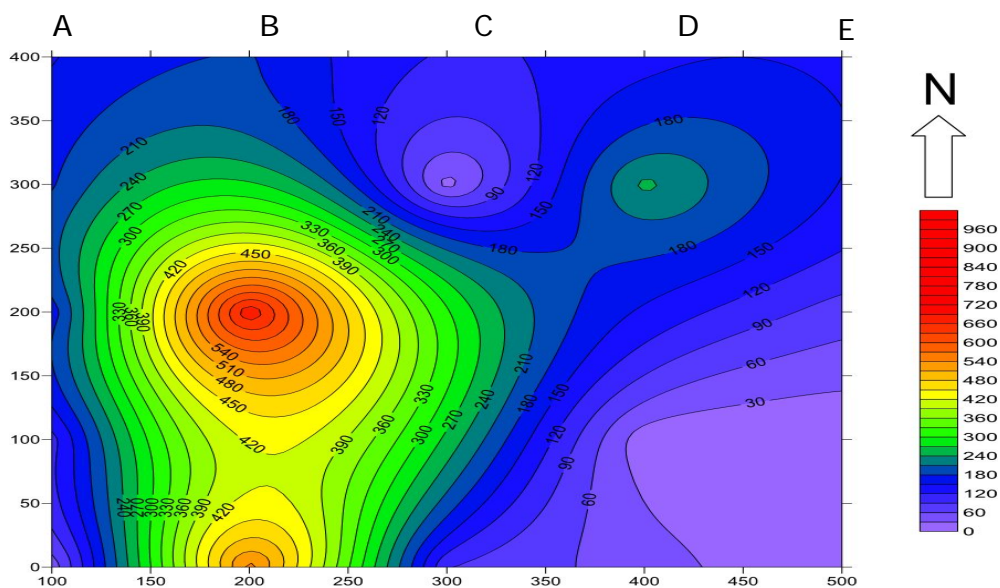


Figure 4: Iso-resistivity contour Map at Surface Contour Interval is 20 Ωm

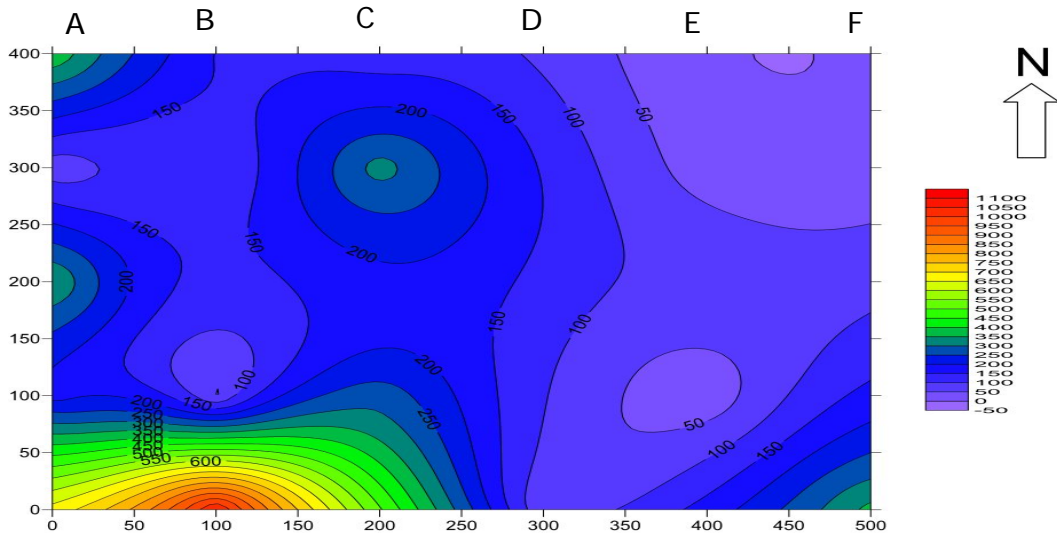


Figure 5: Iso-resistivity contour map at 5 m Contour Interval is 50 Ωm

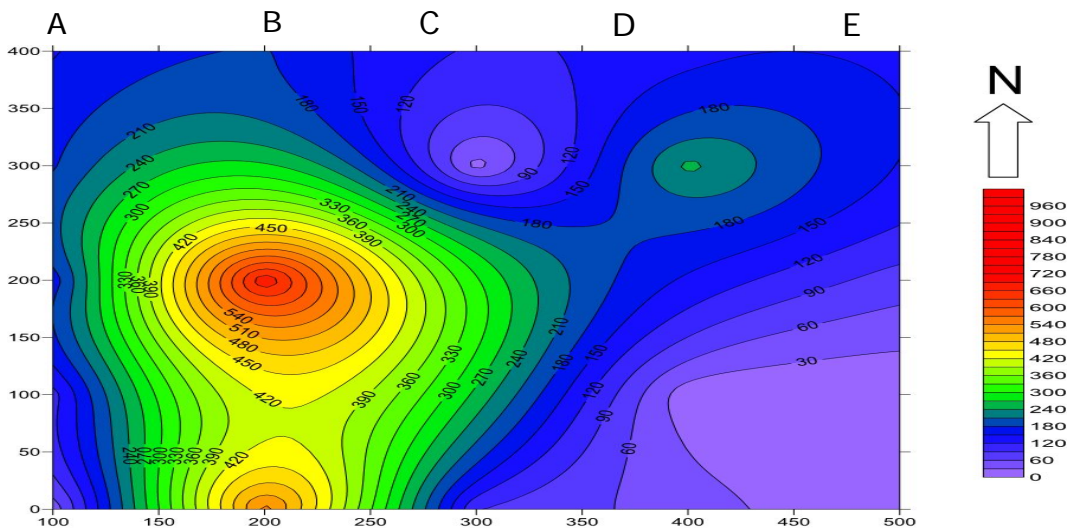


Figure 6: Iso-resistivity contour Map at 10 m Contour Interval is 30 Ωm

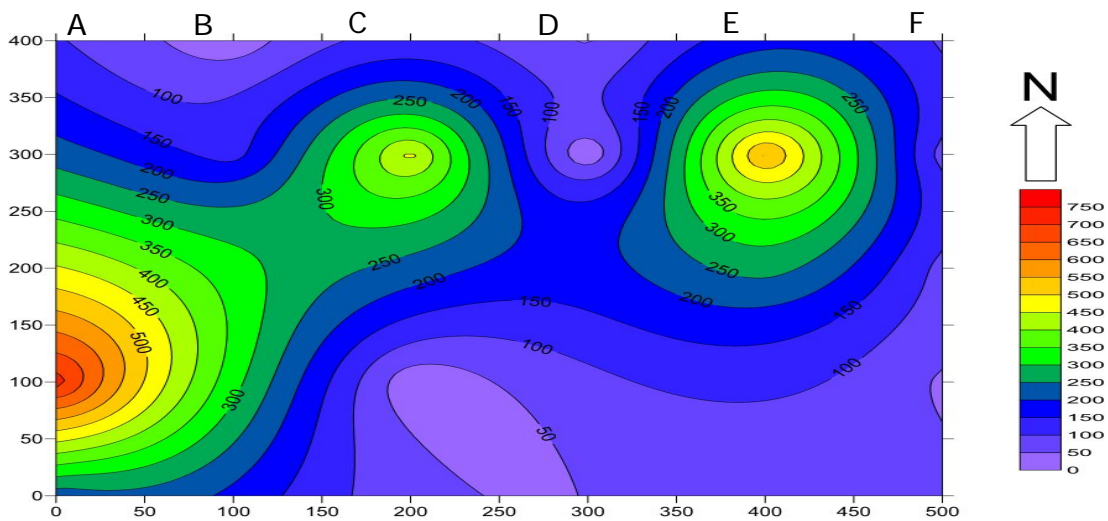


Figure 7: Iso-resistivity contour Map at 20 m Contour Interval is 50 Ωm

Interpretation of Geo-electric Vertical Section along Profile

The vertical geo-electric section of profile A to E and their corresponding geologic sections are shown in figure 8 to 12. The maps were obtained using the values on tables 2a and 2b

Interpretation of Geo-electric Vertical Section along Profile A

The vertical geo-electric section of profile A is as shown in figure (8a) while its corresponding geologic section is shown in figure (8b). The map is contoured at an interval of 70 Ωm . This map can be divided into three layers. Profile A has top soil with resistivity ranging from 140 Ωm to about 900 Ωm . This high resistivity is due to concrete from the construction work. It is followed by a layer of clay saturated with ground water with resistivity ranging from 30 Ωm to 150 Ωm

Interpretation of Geo-electric Vertical Section along Profile B

The vertical geo-electric section of profile B is as shown in figure (9a) while its corresponding geologic section is shown in figure (9b). The map is contoured at an interval of 300 Ωm . This map can be divided into three layers.

The top soil with resistivity ranges from 300 Ωm -600 Ωm . The isolated point B3 with high resistivity is a concrete from construction of school building. The second layer of clay saturated with ground water with low resistivity ranging from 300 Ωm downward dominates the area to about 30 metres.

Interpretation of Geo-electric Vertical Section along Profile C

The vertical geo-electric section of profile C is as shown in figure (10a) while its corresponding geologic section is shown in figure (10b). The map is contoured at an interval of 200 Ωm . This map can be divided into three layers.

The first layer has resistivity values ranging between 10.00 Ωm to 92.00 Ωm as shown in table 4.3. This spread through the entire profile and at different depths. The highest resistivity value of (92.00 Ωm is found at VES C₂ and the lowest value of 10.00 Ωm is at VES C₄), which is an outcrop due to erosion. The thickness of this layer ranges between 0.3 m to 8.0 m. The highest thickness of about 20.0 m occurs at VES B₄, while the least thickness of about 0.8 m occurs at VES B₅. The lithology around this area suggests that this layer could be sand and gravels. The second layer could be fresh basement with very negligible aquifer potential. The layer has resistivity values ranging between 200.00 Ωm to 1800.00 Ωm . The layer covers the entire profile.

Interpretation of Geo-electric Vertical Section along Profile D

The vertical geo-electric section of profile D is as shown in figure (11a) while its corresponding geologic section is shown in figure (11b). The map is contoured at an interval of 300 Ωm . This map can be divided into two (2) layers.

Profile D has lateritic top soil observed at D1, D2, D5 and D6 with resistivity ranging from 40 Ωm to 120 Ωm . There is an outcrop of granite at D3 which corresponds to high resistivity greater than 700 Ωm outward to about 30 metres. The weathered basement stretches up to 30 metres across the profile.

Interpretation of Geo-electric Vertical Section along Profile E

The vertical geo-electric section of profile E is as shown in figure (12a) while its corresponding geologic section is shown in figure (12b). The map is contoured at an interval of 120 Ωm . This map can be divided into two layers. Profile E has top soil from E2-E6 with

low resistivity ranging from 40 Ω m to about 760 Ω m. A high resistivity outcrop of weathered basement is found at E1 which extends 30 metres from E2-E6.

Table 2a: Resistivity values for VES on profile A & B

Prifile A			Prifile B		
X	Y* -1	RES	X	Y	RES
0	-300	38.5	0	-300	179.7
0	-200		0	-200	1670.45
0	-150		0	-150	3400.67
0	-100		0	-100	900.34
0	-50	38.3	0	-50	470.6
0	0	1977	0	0	749.3
100	-300	3.4	100	-300	1020.4
100	-200	1058	100	-200	700.45
100	-150	720.1	100	-150	1600.56
100	-100		100	-100	350.4
100	-50		100	-50	2000.35
100	0		100	0	3500
200	-300	1.6	200	-300	2300.35
200	-200		200	-200	500.79
200	-150	504.5	200	-150	1700.12
200	-100	1229	200	-100	870.78
200	-50	257.2	200	-50	6223
200	0		200	0	900.23
300	-300	56.6	300	-300	161.2
300	-200	56.6	300	-200	350
300	-150	208.5	300	-150	120.45
300	-100		300	-100	1450.6
300	-50	44	300	-50	890.54
300	0	2264	300	0	340.89
400	-300	3.8	400	-300	94.8
400	-200		400	-200	16
400	-150	11.3	400	-150	479
400	-100		400	-100	
400	-50		400	-50	
400	0		400	0	
500	-300	365.9	500	-300	127.7
500	-200	365.9	500	-200	
500	-150		500	-150	
500	-100	16.5	500	-100	30.2
500	-50		500	-50	157.2
500	0		500	0	39.5

Table 2a: Resistivity values for VES on profile A&B

profile C			profile D		
X	Y* -1	RES	X	Y* -1	RES
0	-300	54.9	0	-300	216.4
0	-200	354.5	0	-200	70
0	-150		0	-150	
0	-100		0	-100	
0	-50	3100	0	-50	
0	0		0	0	

100	-300	92.5	100	-300	101.8
100	-200		100	-200	101.8
100	-150	541.1	100	-150	117.4
100	-100		100	-100	
100	-50		100	-50	
100	0	749.3	100	0	
200	-300	47.2	200	-300	230.1
200	-200		200	-200	323.1
200	-150	197.7	200	-150	
200	-100		200	-100	702.9
200	-50		200	-50	
200	0		200	0	
300	-300	10	300	-300	2.1
300	-200		300	-200	
300	-150		300	-150	150.4
300	-100	963.1	300	-100	
300	-50		300	-50	
300	0	274.6	300	0	
400	-300	91.1	400	-300	457.2
400	-200	91.1	400	-200	24.9
400	-150		400	-150	44
400	-100		400	-100	
400	-50	3.7	400	-50	
400	0		400	0	
500	-300	10.3	500	-300	18.6
500	-200		500	-200	21.6
500	-150	9	500	-150	446.9
500	-100		500	-100	
500	-50		500	-50	
500	0		500	0	

Profile E			Profile E		
X	Y*-1	RES	X	Y*-1	RES
0	-300	393.1	300	-300	38.5
0	-200	198.1	300	-200	
0	-150		300	-150	
0	-100	61.7	300	-100	38.5
0	-50	229.8	300	-50	4.5
0	0		300	0	59.9
100	-300	147.3	400	-300	1.5
100	-200	147.2	400	-200	3.3
100	-150		400	-150	37
100	-100		400	-100	
100	-50	159.3	400	-50	
100	0	71.4	400	0	186.3
200	-300	124.3	500	-300	157.6
200	-200	12.3	500	-200	
200	-150	53.9	500	-150	
200	-100		500	-100	77
200	-50		500	-50	
200	0		500	0	1510

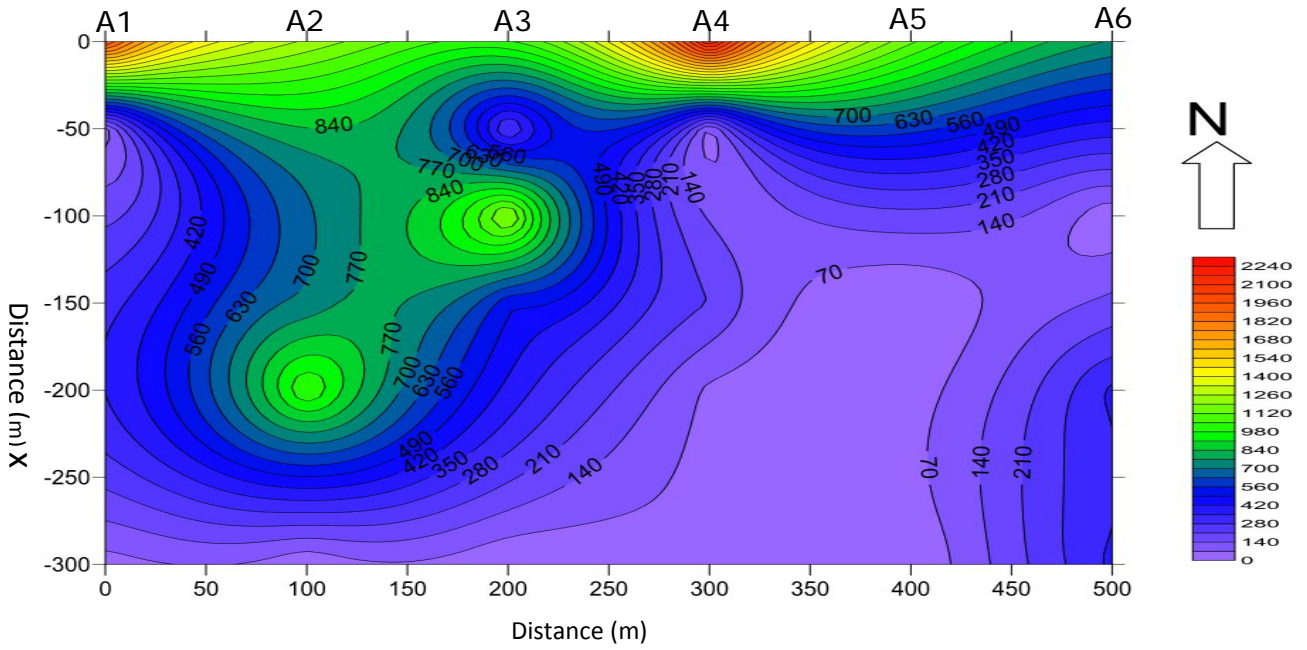


Figure 8a: Geoelectric Vertical section along Profile A (Contour Interval is 70Ωm)

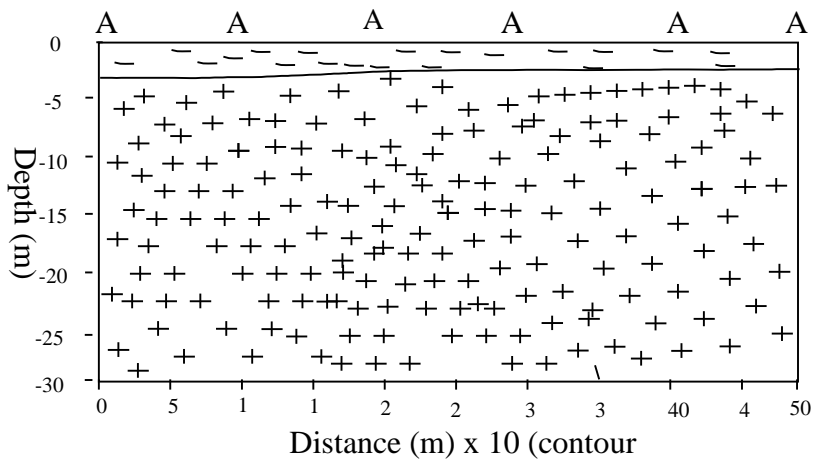


Figure 8b: Vertical Section through Profile A

Legend

- - - -	Top soil
+ + + +	Fresh Basement

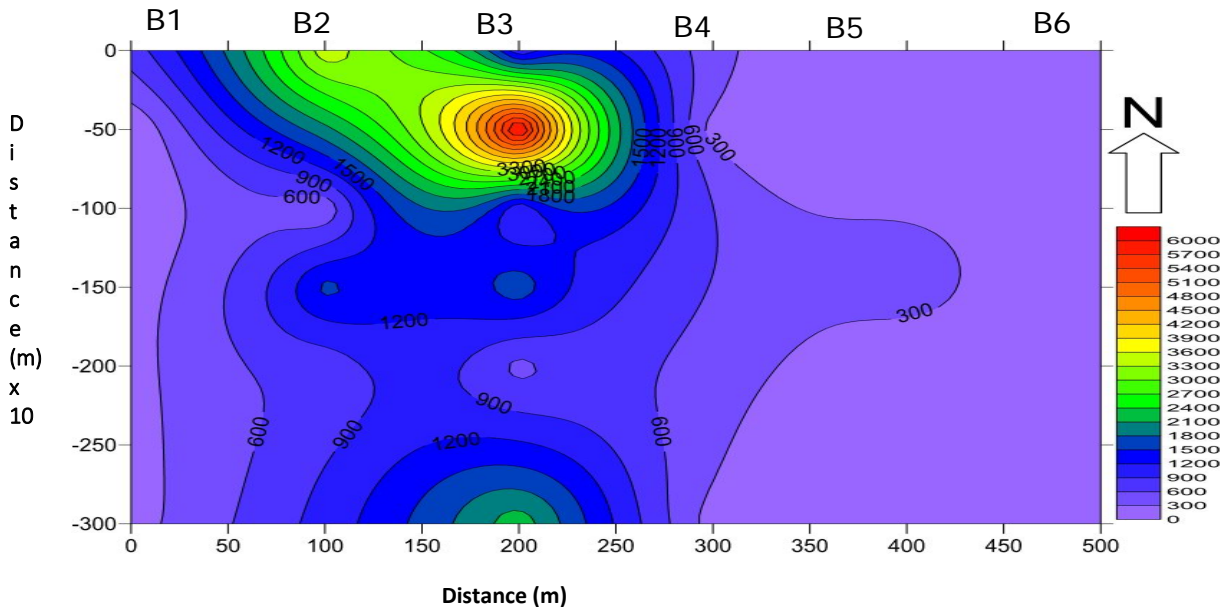


Figure 9a: Geoelectric Vertical section along Profile A (Contour Interval is 70 Ωm)

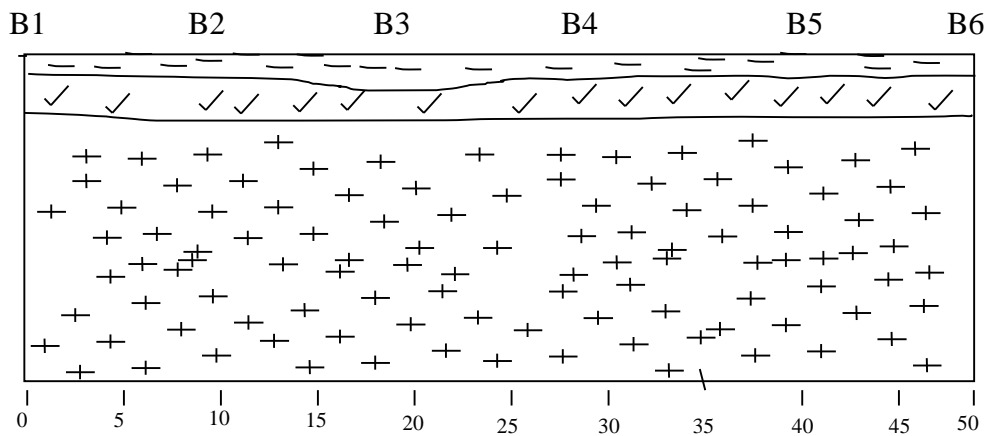


Figure 9b: Vertical Section through Profile B

Legend

	Fadama Loam and Sandy soil
	Weathered Basement
	Weathered Basement

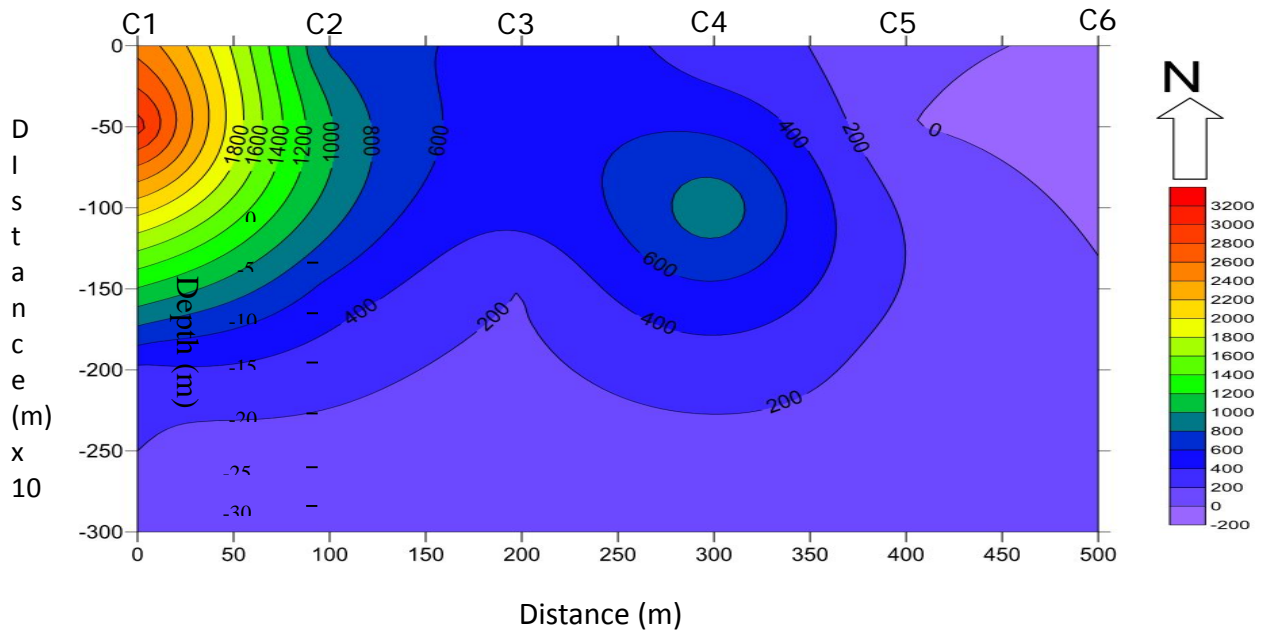


Figure 10a: Goelectric Vertical section along

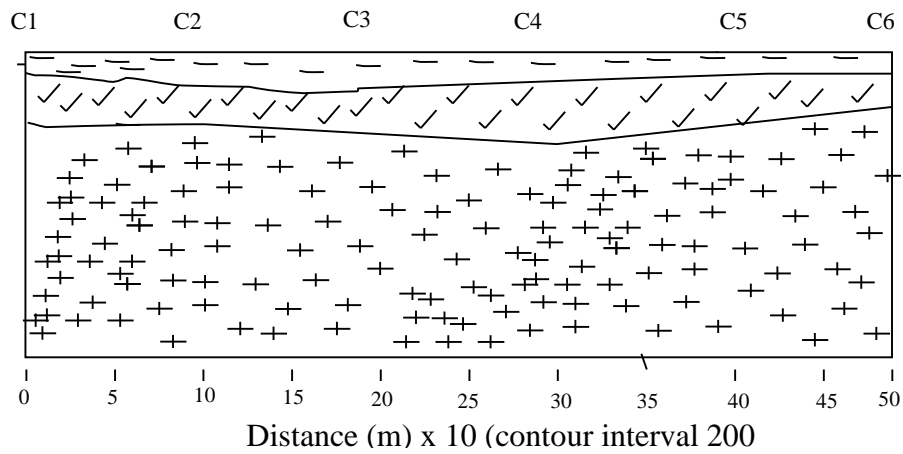


Figure 10b: Vertical Section through Profile C

Legend	
— — — —	Sand and Gravels
✓ ✓ ✓ ✓ ✓	Laterite
+ + + + +	Weathered Basement

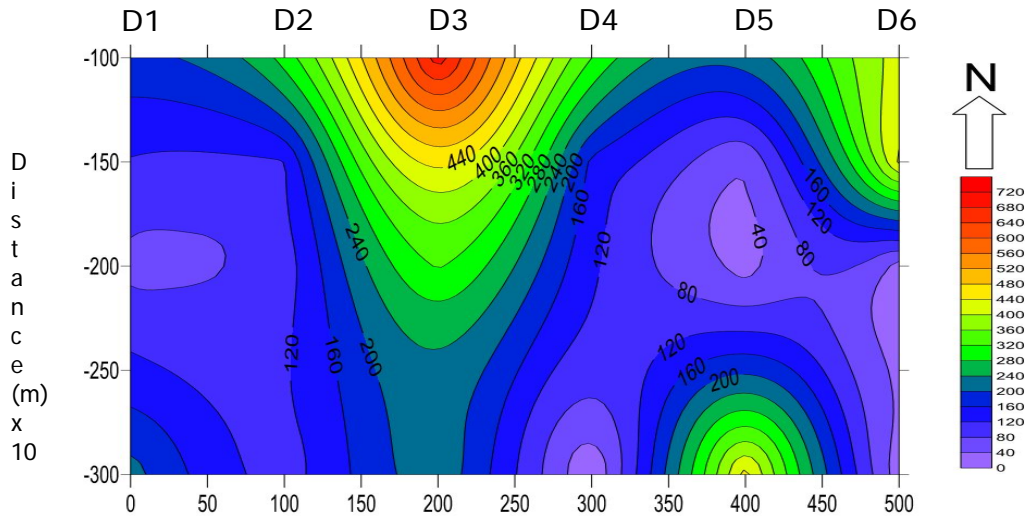


Figure 11a: Geoelectric Vertical section along Profile D (Contour Interval is $300 \Omega m$)

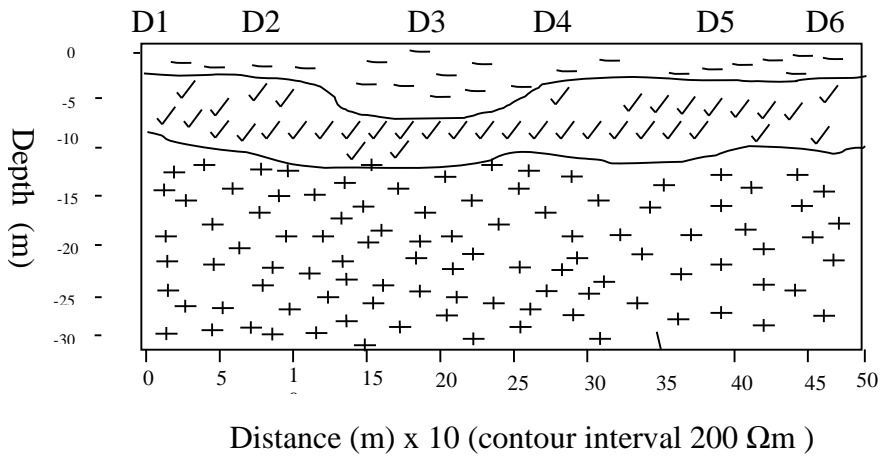


Figure 11b: Vertical Section through Profile D

Legend

	Top soil
	Laterite
	Weathered Basement

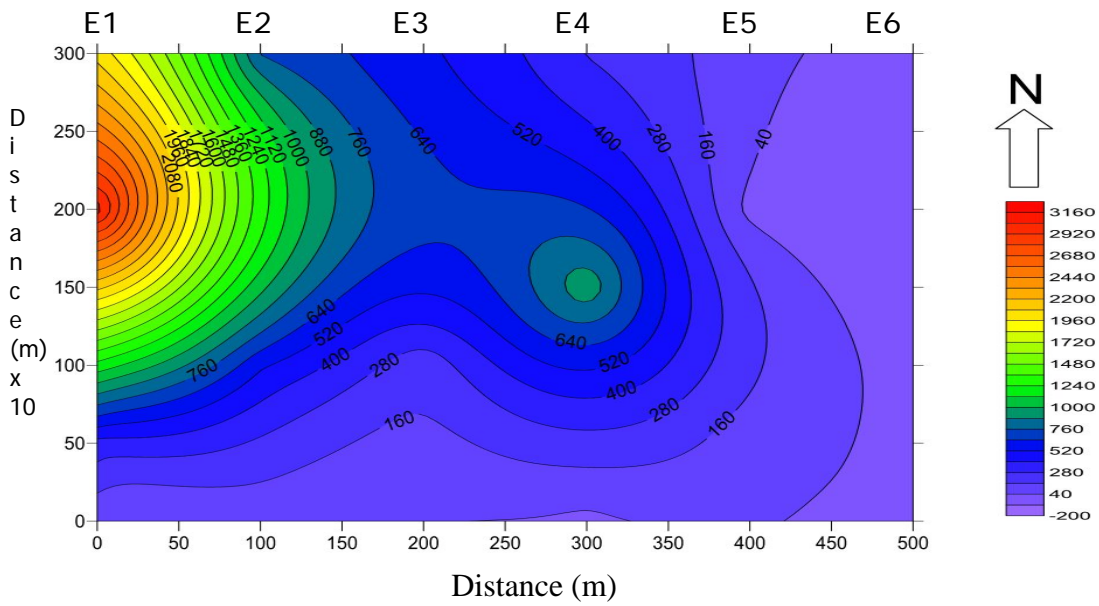


Figure 12a: Geoelectric Vertical Section along Profile E (Contour Interval is 120 Ωm)

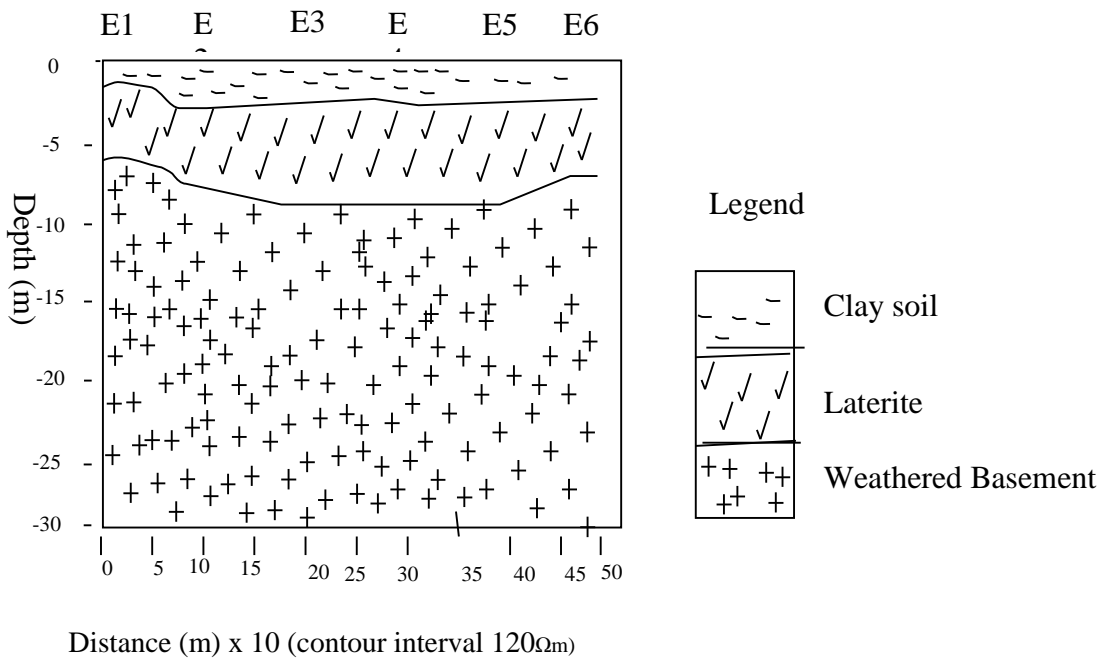


Figure 12b: Vertical Section through Profile

on VES points A1-A3. The low resistivity values observed on A4-A6 which is as low as 70 Ωm could be a clear indication of weathered basement up to a depth of 30 metres (see table).

Conclusion

In this study, electrical resistivity method using vertical electrical sounding (VES) was carried out on 30 VES points sounded using the Schlumberger electrode array with a view to understand the subsurface geologic settings that could guide the successful exploration of groundwater.

Details of the result show that VES C3, D5, E3, E4 are viable for ground water exploration. VES E2 shows presence of ground water in weathered basement at a depth of equally 20 metres. The entire area can be classified into three geological units. The top soil which varies in thickness from 0 to 1 metres followed by clay layer that varies in thickness from 1 m to about 5 metres, weathered basement that ranges from 5 to about 20 metres and finally, fresh basement which varies from 20 metres to infinity.

Recommendations

Electrical resistivity method has been successfully adopted in this search for subsurface water exploration. It is therefore recommended that a borehole be drilled at any VES points located on profiles D and E, from a depth of about 40 meters to 50 meters.

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PREPARATION AND CHARACTERIZATION OF COPPER (I) OXIDE/COPPER (I) SULPHIDE HETEROJUNCTION FOR PHOTOVOLTAIC APPLICATIONS

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Abstract

This paper presents the formation of n-copper (I) oxide/p-copper (I) sulphide (n-Cu₂O/p-Cu₂S) heterojunction. Firstly, the formation of n-Cu₂O layer was carried out by heating copper foil in 0.1M CuSO₄ solution at 80°C for 1 hour and subsequently annealed at 250°C for 2 hours. The particle morphological and mineralogical phase of the developed n-Cu₂O layer was examined using Scanning Electron Microscope (SEM) and X-ray Diffraction (XRD). It was physically observed from the SEM micrographs that the grain sizes of the material appear to be larger after annealing. X-ray Diffraction (XRD) analysis reveals the formation of Cu₂O (111) plane at $2\theta = 36.4^\circ$, Cu₂O (110) plane at $2\theta = 29.5^\circ$, Cu₂O (200) plane at $2\theta = 42.3^\circ$ and Cu₂O (220) plane at $2\theta = 61.3^\circ$. Secondly, the n-Cu₂O/p-Cu₂S heterojunction was formed by partial sulphidation of the n-Cu₂O in 0.5M Na₂S solution. The n-Cu₂O/p-Cu₂S heterojunction formed, when exposed to sunlight, produced a short-circuit current density, J_{sc} , and open-circuit voltage, V_{oc} , of 77 $\mu\text{A}/\text{cm}^2$ and 45mV, respectively. Finally, manual formation of grids on the p-Cu₂S layer enhanced the values of J_{sc} and V_{oc} to 96 $\mu\text{A}/\text{cm}^2$ and 52mV, respectively. These results are an improvement over previously reported values on this heterojunction.

Keywords: n-Cu₂O, chemical heating, n-Cu₂O /p-Cu₂S heterojunction.

Introduction

Solar cells are devices that convert sunlight into electrical energy and for this they are called Photovoltaic (PV) devices (Green, 1982). There are presently few PV cells that are widely used in commercial quantities. These are silicon pn-junction solar cells, cadmium sulphide/copper sulphide (CdS/Cu₂S), gallium arsenide (GaAs) and amorphous silicon (a-Si) solar cells. However, it has been predicted that the future development will be hampered by high cost of material and fabrication methods. For large scale power generation using these cells, there should be a drastic reduction in the cost of the cells. One of the cheapest solar cells now being investigated by researchers across the globe is the cuprous oxide-based (Cu₂O-based) solar cells. Cuprous oxide is one of the early semiconducting materials whose photovoltaic effects were discovered in 1904 (Musa, 1998). It has promising theoretical electrical power conversion efficiency of about 20% with a very cheap starting material, which is copper. Other unique features that make Cu₂O attractive for photovoltaic applications are, availability of copper, its non-toxicity and having a direct bandgap of about 2.1eV (Siripala et al., 1996 and Mahalingam et al., 2000). Researchers have reported different methods of depositing Cu₂O layers such as electrodeposition (Economou, et al.; 1982, Mahalingam et al., 2005, Wijesundara et al., 2000, Santra, et al; 1999), thermal oxidation (Musa et al., 1998, Minami, et al; 2016), reactive magnetron sputtering (Akimoto et al., 2006, Mugwang, 2013, Herion et al., 1980, Pearson, et al; 2003, Reddy, et al; 2008), chemical-bath (Fernando et al., 2002), amongst others. On the other hand, Cu₂O layers deposited via these methods were found to be p-type. Furthermore, the low efficiency of the Schottky solar cell of 1.2% (Tanaka, et al., 2004) and 1.8% (Olsen, et al, 1982), which proved to be higher than other types of the Cu₂O-based solar cells have led to the establishment that the best approach to improve Cu₂O solar cell efficiency is the production of both p-type and n-type Cu₂O and thus forming a p-n homojunction of Cu₂O. This

homojunction will, not only provide a better lattice matching between the layers equally reduce losses due to charge carrier recombination. Conversely, a p-n homojunction of Cu_2O layers was fabricated and solar cell based on this was found to have efficiency of 0.1% (Longchen & Meng, 2007; Kunhee & Meng, 2009). The low efficiency of the cell was attributed to high series resistance of the oxide layers. Thus it became imperative to identify or possibly develop methods of reducing the high series resistance for the purpose of improving the efficiency of the homojunction. However, electrical power conversion efficiencies of 2% (Mittiga, *et al.*; 2006) and 3.83% (Minami, *et al.*, 2011) were reported, using Cu_2O p-n heterojunction solar cells. It is worthy of note that up to the time of this report, the highest efficiency obtained is 3.83%, using Cu_2O heterojunction. This served as a motivation for the present work. Earlier, Fernando and Wetthasinghe, (2000) have reported the possibility of obtaining n-type photo-responses from clean copper plates, immersed in CuSO_4 solution for a few days. Subsequently, Fernando *et al.*, (2002) reported the n-type Cu_2O produced by boiling copper sheets in CuSO_4 solution. This work focuses on the formation of heterojunction with n- Cu_2O layer based on a heating method using copper in CuSO_4 solution to produce the n- Cu_2O layer (Musa & Abdu, 2016). The heterojunction will be formed using a p-type copper (I) sulphide (p- Cu_2S) layer.

Experimental Procedure

Sample Preparation

The starting material, copper foil sheet (0.1mm thickness and 99.99% purity) was cut into 1cm x 2cm sample sizes. The samples were then polished to ensure smooth surface of the copper foil. They were finally washed to remove any possible dirt on their surface and then dried between tissue papers.

Physical, Structural and morphological analysis of the deposited n- Cu_2O layer was carried out using Scanning Electron Microscope (SEM) (model phenom, Pro X). Identification of the material deposited was done using X-ray Diffractometer (XRD) (model Empyrean diffractometer DY 674).

Solution Preparation

Anhydrous copper (II) sulphate of purity 99.0% (BDH-GPR) of molecular weight 156.60 was used. To prepare 0.1M CuSO_4 solution, 0.0157g of the anhydrous copper sulphate was dissolved in 1litre of de-ionized water. The partial sulphidation of the Cu_2O requires Na_2S solution. The preparation of 0.05M Na_2S was done by dissolving 0.0039g of the anhydrous Na_2S , molecular weight 78.04, in 1000 litres de-ionized water.

Deposition of n- Cu_2O

The deposition of the n-type Cu_2O layer was done using chemical bath deposition method. The deposition was carried out by taking 100cm³ of the 0.1M CuSO_4 solution in a beaker. The beaker containing the solution was put into a water bath and heated at 60°C for 1 hour. The same process was repeated for temperatures of 65°C, 70°C, 75°C and 80°C. One copper sample was considered at a time for each setup and was heated in the solution for about one hour.

The sample was finally, removed and washed in distilled water severally and then dried between tissue papers. The procedure was repeated for solution concentrations of 0.001M, 0.006M, 0.01M and 0.04M under the same temperature conditions as above.

Annealing

The annealing process was carried out in a VECSTAR furnace for 30 minutes at 250°C. The sample was then removed, quenched and finally dried in air. The annealing process was

carried out in order to achieve healing of defects created during the deposition, lowering the resistivity of the layer and improving on the grain size of the crystals. It is well known that opto-electric materials perform better when their resistivity is low.

Formation of p-Cu₂S Layer

It has been established that Cu₂S is a p-type semiconducting material with a band-gap of 1.2-1.93eV (Varkey, 1990 & Fajinmi, 2000). This makes it suitable for use as a window material. It is used, in this work, with an n-type Cu₂O material to form a p-n heterojunction.

The formation of Cu₂S was carried out using 0.05M Na₂S solution. The Cu/n-Cu₂O substrate was immersed in the Na₂S solution for about 5-10 seconds and finally removed and dried in air. The samples were annealed at a temperature of 250°C for 30 minutes.

Grids Formation

Grid patterns serve the purpose of providing contact to the cell for current collection as well as reducing the contribution of the sheet resistance to the series resistance of the cell (Musa *et al.*, 1998). Gold and silver have lower contact resistance compared to aluminum because of their higher conductivity values. Silver paste paint is used in forming grids in this work for the above reasons. The grids pattern is made manually formed, in a comb shape, on top of the p-Cu₂S layer which serves as a window for the sunlight reaching the n-Cu₂O/p-Cu₂S heterojunction.

Determination of Conductivity Type of the Cu₂O Layer

The conductivity type was determined using the hot probe method (Bar-lev, 1979) figure 1.

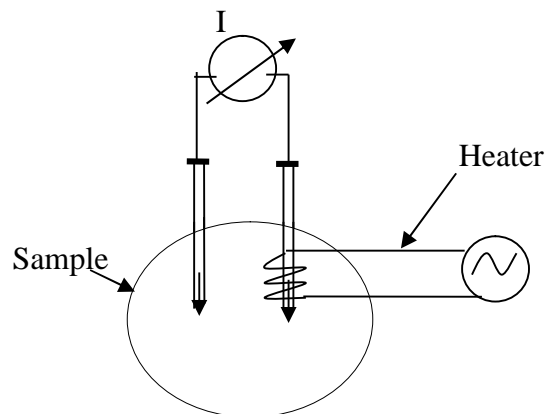


Fig.1 Hot probe method

The conductivity type measurement was carried out using the hot probe method. The surface of the sample was touched by two identical probes of soldering equipment connected to a galvanometer. One of the probes was heated while the other was left at room temperature, Fig. 4.1. The Hot probe heated the sample immediately under it; this increased the kinetic energy of the free carriers. The heated carriers then moved with higher velocity than their cooler neighbors. The carriers therefore, diffused out of the hot region faster than their slower neighbors can diffuse back into it from the vicinity. This resulted in the hot region becoming slightly depleted of majority carriers and acquiring the potential of the ionized impurities there, while the vicinity of the cold probe remained neutral. Current, therefore, flowed in the galvanometer, the direction of which relied on the sign of the charge of the ionized impurity. Thus, on an n-type semiconductor, the hot probe is the more positive one, while on a p-type it is the more negative. The cold probe polarity therefore,

indicates the type. The direction of current flow was found to be consistent with that of an n-type material. Also, Schottky effect was tested to confirm the conductivity type of the material. There was no any photo-voltage detected at the metal-semiconductor junction and no current was recorded flowing through the junction. If the material deposited were p-type, there would have been voltage and current to confirm the existence of the Schottky effect between the metal-semiconductor.

Results and Discussion

Copper samples heated at temperatures below boiling point, in solutions having concentrations of 0.001M, 0.006M, 0.01M and 0.04M Cu_2SO_4 , have not shown any sign of material deposition on them at the various time intervals considered. However, the copper samples heated in 0.1M Cu_2SO_4 solution, below the boiling point at 80°C had reddish brown deposits on them but non-uniform.

Increase in the heating time above 2hrs did not show any visible change in the appearance of the deposited films. There was no layer dissolution observed throughout the exercise unlike in the reported boiling method (Fernando *et al*, 2002). However, the best sample was that obtained by chemical heating at 80°C for 1 hour and thereby considered for analysis in this work. This sample has a very uniform layer deposited.

Sem Micrographs Analysis

The surface morphology of the deposited layer, before and after annealing, was displayed in the SEM micrographs of figure. 2(a) and 2(b), respectively. Physical examination of the SEM micrographs revealed that the n- Cu_2O layer is composed of grains of different sizes and also there exist some black spots, which are predicted to be crystal defects, which, after annealing, were healed and disappeared. Physically, the crystal grains are smaller in figure, 2(a) than when the sample was annealed in figure. 2(b), showing an improvement in the grain size.

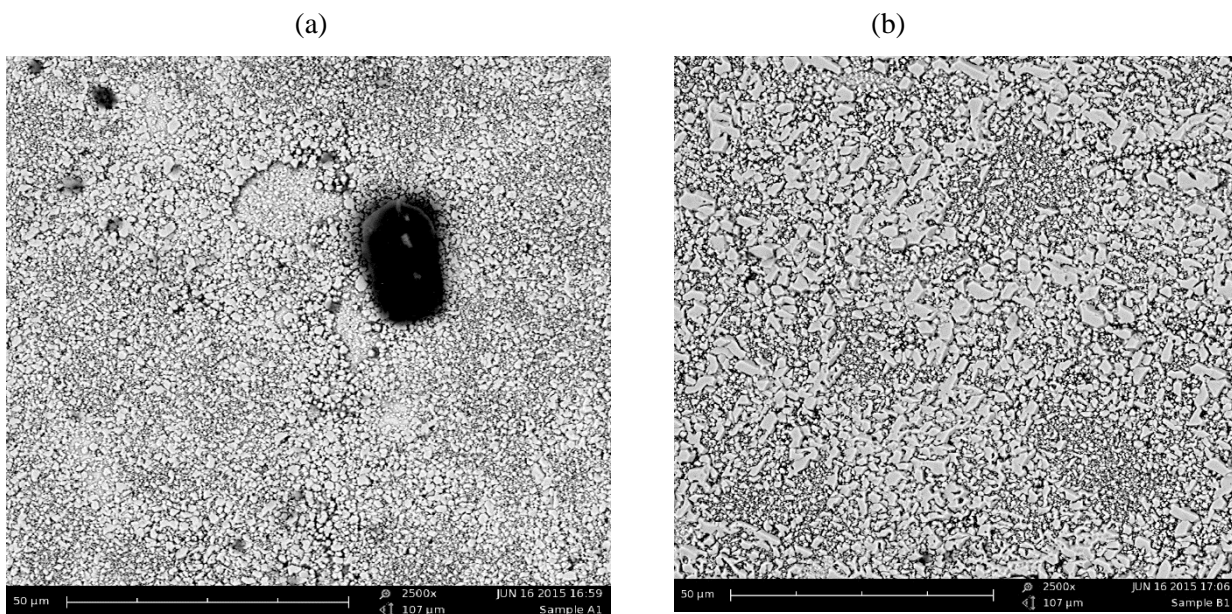


Fig.2: SEM micrographs of n- Cu_2O obtained by heating copper in 0.1M Cu_2SO_4 solution at 80°C (a) before annealing (b) after annealing, at x 2500 magnifications

X-Ray Diffraction Spectra Analysis

The structural and phase identification for the deposited n-Cu₂O were studied using XRD. The XRD spectra are shown in the figure. 3. These diffraction peaks at 2θ value of 36.4°, 29.5°, 42.3° and 61.3° corresponds to crystal plane (111), (110), (200) and (220), respectively.

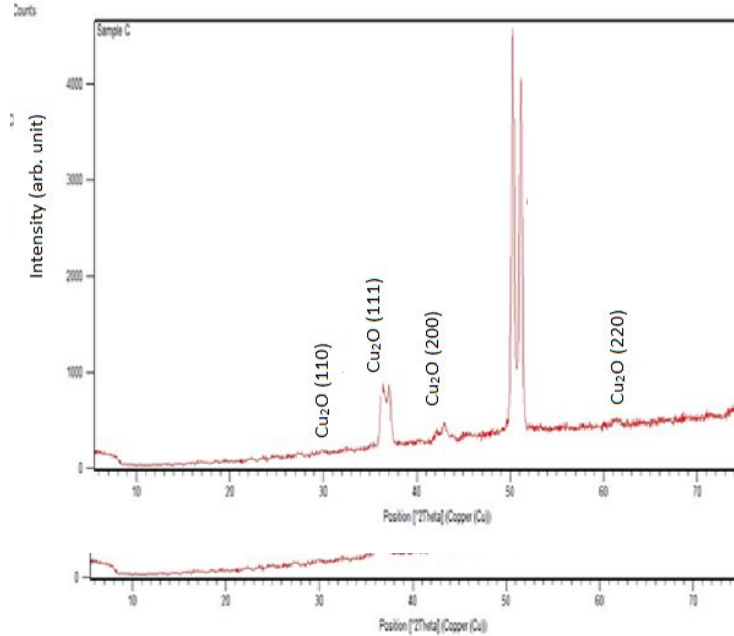
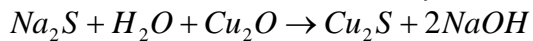


Fig 3: XRD spectra of n-Cu₂O obtained by heating copper in 0.1M CuSO₄ solution at 80°C.

Sulphidation of n-Cu₂O

The immersion of n-Cu₂O in Na₂S solution made its surface appears dark due to the formation of Cu₂S. The reaction predicted to have taken place is:



Measurement of the Short Circuit Current Density (J_{sc}) and Open Circuit Voltage (V_{oc})

The highest values for the short circuit current density, J_{sc} and the open circuit voltage, V_{oc} measured, for the n-Cu₂O/p-Cu₂S heterojunction formed without grids are 77 μAcm^{-2} and 45mV, respectively. However, after the grids were formed, the best junction has J_{sc} and V_{oc} values of 96 μAcm^{-2} and 52mV, respectively. This clearly shows that the grids enhanced the performance of the junction. These values are an improvement over the reported values for J_{sc} and V_{oc} of 75 μAcm^{-2} and 45mV, (Abdu, 2011) and 87.12 μAcm^{-2} and 60mV (Abdu & Ibrahim, 2014), respectively. The n-Cu₂O layers for the reported results were formed by the chemical boiling and immersion methods, respectively.

Conclusion

The formation of Cu₂O layer by simple chemical method of heating copper plates in 0.1M Cu₂SO₄ solution at 80°C for one hour was achieved. The hot probe experiment confirmed that the Cu₂O film obtained is n-type. Formation of the heterojunction was achieved by sulphiding the Cu₂O top layer thereby partially converting it into Cu₂S, which is p-type. The heterojunction formed exhibited photovoltaic effect on exposure to sunlight. It has been observed that grids formation enhanced the values of J_{sc} and V_{oc} ; the highest values obtained are 96 μAcm^{-2} and 52mV, respectively. These values are an improvement over

reported results for n-Cu₂O/p-Cu₂S heterojunction with n-Cu₂O deposited using different methods.

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INTERPRETATION OF AEROMAGNETIC DATA OVER PARTS OF BIDA BASIN, NORTH CENTRAL, NIGERIA

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Abstract

Interpretation of Magnetic Signatures over parts of central Bida Basin, Nigeria was carried out to highlight linear structures and to suggest the viability of the basin for hydrocarbon potentials in the survey area. Aeromagnetic data over the study area bounded by latitudes 8.50°N to 10.00°N and longitudes 5.00°E to 6.00°E was interpreted with a view to study the magnetic trends and to estimate the sedimentary thickness within the study area. Trend characteristics of magnetic lineaments were analysed using First Vertical Derivative. Source Parameter Imaging was used to estimate the sedimentary thickness. The Lineaments from the First Vertical Derivative trends majorly in NE-SW direction. The occurrence of subsurface linear structures may be due to discontinuities caused by faulting of country rock and this is in conformity with the history of the formation of the Bida Basin. The result of Source Parameter Imaging shows that depth to magnetic sources has its maximum sedimentary thickness of about 3.0 km in the south and central part of the study area. The sedimentary thickness of about 3.0 km might be sufficient for hydrocarbon maturation in the area.

Keywords: *Basement, Lineaments, Magnetic Trend, Source Parameter Imaging, First Vertical Derivative*

Introduction

The interpretation of aeromagnetic maps involves interpreting the basement structures and detailed examination of structures. The digitization method adopted for the study was the manual visual interpolation method. The aim of a magnetic survey is to investigate subsurface geology on the basis of anomalies in the earth's magnetic field resulting from the magnetic properties of the underlying rocks. Therefore, the aim is to determine the thickness of Bida Basement. Magnetic prospecting thus involves the measurement of variations in the earth's magnetic field. It is natural source methods in which local variations introduced by magnetic properties of rock near the surface causes minute changes in the main field. Determination of the structure and nature of the magnetized material is therefore an inverse problem of potential field theory. That is, the source is determined from its potential (Grant & West, 1965).

Geology of the Area

The study area is located within the Bida Basin (also known as the Middle Niger Basin or the Nupe Basin) in the west - central part of Nigeria. The study areas cover Fashe, Akerre, Mokwa, Egbako, Lafiagi and Pategi. All the rocks in the study area belong either to the Upper Cretaceous or to the Precambrian. The sandstones of the Bida Basin belong to the Upper Cretaceous and they are underlain by the Precambrian rocks of the Basement Complex. (Russ, 1957; Adeleye, 1973 & 1976; Udeni *et al*, 2003). The Nupe sandstones consist of slightly cemented fine to coarse-grained sandstones and siltstones with interbedded thin beds of carbonaceous shales and clays. The Nupe sandstone appears to lie directly on the Basement (Adeleye, 1976). Figure 1 (Map of Nigeria) shows the location of the Study Area and Figure 2 is the geological map of the area. It lies between latitude 8.50°N and 10.00°N and longitude 5.00°E and 6.00°E.

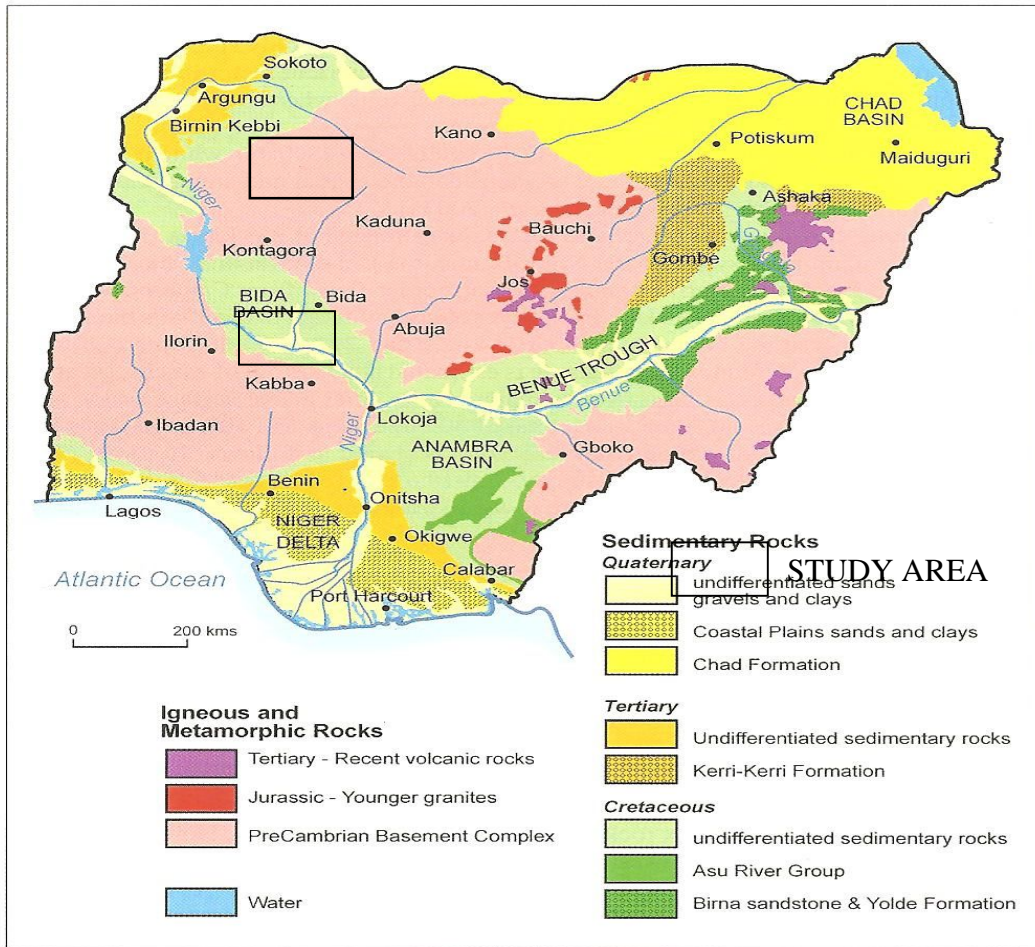


Figure 1: Generalized Geological Map of Nigeria (Olasehinde & Amadi, 2009)

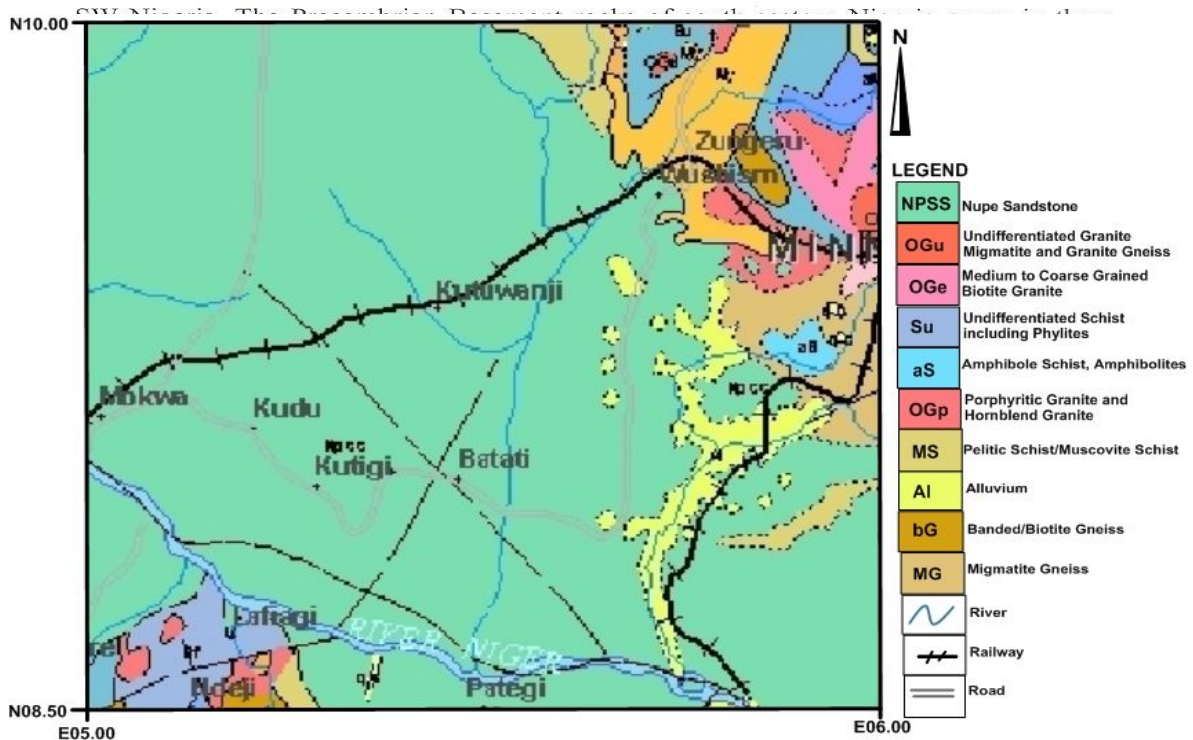


Figure 2: Geological Map of the Study Area (Adapted from Nigeria Geological Survey Agency, 2006)

Materials and Method

Materials

Data acquisition and analysis: Airborne magnetic survey of a substantial part of Nigeria was carried out by the Nigerian Geological Survey Agency between 1974 and 1980. The magnetic information consists of profiles or repetition flight lines plotted on continuous strip chart or tape records. To achieve this, the Nigerian landmass was divided into blocks. The magnetic data were collected at a nominal flight altitude of 500 ft (152.4m) along north-south flight lines spaced approximately 2 km apart. The data were published in the form of $\frac{1}{2}$ degree by $\frac{1}{2}$ degree aeromagnetic maps on a scale of 1:100, 000. The magnetic values were plotted at 10 nT intervals. The maps were numbered and names of the places of each map covers were written on them for easy reference. A total of 340 maps cover the entire country. The aeromagnetic maps covering the study area have been acquired from the Nigeria Geological Survey Agency. The study area is covered by aeromagnetic maps of sheet number 161,162,181,182, 203, and 204. The actual magnetic values within this block were reduced by 25,000 nT before plotting the contour maps. This means that a value of 25,000 nT was added to the contour values so as to obtain the actual field at a given point.

A correction based on the International Geomagnetic Reference Field (IGRF) epoch date January 1, 1974 was included in all the aeromagnetic maps published by the Nigerian Geological Survey Agency.

Aeromagnetic Map Digitization

The Magnetic data for this research was acquired from the aeromagnetic maps covering part of the Bida Basin. The digitization method adopted for this study was the manual visual interpolation method. The visual interpolation method involves drawing of straight lines vertically and horizontally at equal spacing on a tracing paper to form a grid layout. The boundaries of the layout must coincide with the boundaries of the aeromagnetic map layout to be used for digitization (Udensi *et al.*, 2000). The layout is overlain on the aeromagnetic map and magnetic values were read at the junctions or cross points on the grid system. At grid points where the contour lines do not cross, visual interpolation to the closest contour line is made so as to estimate the magnetic value at the grid point. Since the grid points are evenly spaced, it is easy to determine the longitude and latitude of each grid point. The grid layout may be rectangular or square depending on the wish of the interpreter or the nature of the area concerned.

Production of Dataset (Super Data)

The data from each digitized map is stored in a 37 by 57 coding sheet. Each sheet contains records of the boundary longitude and latitude, the map number and name of the town. The problem of boundary (edge) has to be solved before the combined dataset is produced. This problem is illustrated in (Figure 2), which represents a rectangular outline of the study area, Lafiagi, Pategi, Mokwa, Egbako, Fashe and Akerre sheets. Each small map is represented by the map number and contains 19 by 19 digitized magnetic values. At the boundary of two maps for example, maps (161) and (162), the field values in the last column of map (161) have the same coordinates (latitude and longitude) as the field values at the first column of map (162). Also at the boundary between map (161) and (182) the field values at the last row of map (161) have the same coordinates as the field values in the first row of map (182).

To have a dataset therefore, all magnetic values with the same coordinate must be added and averaged. So with this, the rows and columns of magnetic points with the same coordinate will not exist. Two ways through which this task could be achieved are:

- (i) A computer program can be designed to achieved the aim where one is dealing with large numbers of maps say from ten upwards.
- (ii) Use of manual manipulation when dealing with maps below ten, and care must be taken not to run into unnecessary errors.

When the last column and first column of the adjoining map is averaged, the new data value generated is recorded in place of the initial data value; the same process is repeated for the rows between two maps. At the end of this process, a set of data that is 37 by 37 grid was obtained. This gives a total of 1369 data points in the super map. Therefore, manual manipulation process was used for collection of data.

Production of the Unified Aeromagnetic Map (Super Map) of the Study Area

The dataset (super data) cannot yet be contoured because the coordinates (latitude and longitude) of each of the data points are yet to be supplied. This was achieved using another Program like the one used for the small maps, which reads the data points row by row, and calculate their latitudes and longitudes using base values already supplied. The output is then in the form of columns of x, y, z where x, y and z represent longitude, latitude and the magnetic value of the given data point respectively. The output file from this program is subsequently fed into the SURFER- package for the production of the unified aeromagnetic map.

Magnetic data observed in geophysical surveys are the sum of magnetic fields produced by all underground sources. The terms "residual" and "regional" are used to differentiate between anomalies from local, near surface masses and those arising from larger and deeper features, respectively. The target for specific investigations are often small-scale structures buried at shallow depths, and the magnetic response of these targets are embedded in a regional field that arises from magnetic sources that are larger or deeper than the target or are located farther away. Correct estimation and removal of the regional field from the initial field observation yields the residual field produced by the target sources. Interpretation and numerical modelling are carried out on the residual field data; and the reliability of the interpretation depends to a great extend upon the success of the regional-residual separation, (Li & Oldenburg, 1998).

Methods

Vertical derivative

A derivative tends to sharpen the edges of anomalies and enhance shallow features. The vertical derivative map is much more responsive to local influence than to broad or regional effect and therefore tends to give sharper picture than the map of the total field. Vertical derivative operator in the frequency domain is given

by

$$L(r) = r^n \tag{1}$$

Where n is the order of differentiation, and r is the wavenumber (radians/ground unit) The vertical derivative is commonly applied to total magnetic field data to enhance the shallowest geologic sources in the data. As with other filters that enhance the high-wavenumber components of the spectrum, you must often also apply low-pass filters to remove high-wave number noise. This is a measure of the curvature of the field. The second vertical derivative enhances geologic feature which generate greater curvature of the magnetic field. This is the case for anomalies from geologic features that are close to the surface. In addition to enhancing weaker anomalies, the second vertical derivative can often be used to delineate the contacts of lithologies with contrasting physical properties such as densities, and susceptibilities, (Bhattacharyya, 1966; Henderson & Zietz, 1967).

Source Parameter Imaging (SPI)

Source Parameter Imaging (SPI) function is a quick, easy, and powerful method for calculating the depth of magnetic sources. Its accuracy has been shown to be +/- 20% in tests on real data sets with drill hole control. This accuracy is similar to that of Euler deconvolution, however SPI has the advantage of producing a more complete set of coherent solution points and it is easier to use.

A stated goal of the SPI method (Thurston and Smith, 1997) is that the resulting images can be easily interpreted by someone who is an expert in the local geology. The SPI method (Thurston and Smith, 1997) estimates the depth from the local wave number of the analytical signal. The analytical signal $A_1(x, z)$ is defined by Nabighian (1972) as:

$$A_1(x, z) = i \frac{\partial M(x, z)}{\partial x} - j \frac{\partial M(x, z)}{\partial z} \tag{2}$$

Where $M(x, z)$ is the magnitude of the anomalous total magnetic field, j is the imaginary number, z and x are Cartesian coordinates for the vertical direction and the horizontal direction respectively. From the work of Nabighian (1972), he shows that the horizontal and vertical derivatives comprising the real and imaginary parts of the 2D analytical signal are related as follows:

$$\frac{\partial M(x, z)}{\partial x} \Leftrightarrow - \frac{\partial M(x, z)}{\partial z} \tag{3}$$

Where \Leftrightarrow denotes a Hilbert transformation pair. The local wave number k_1 is defined by Thurston and Smith (1997) to be

$$k_1 = \frac{\partial}{\partial x} \tan^{-1} \left[\frac{\frac{\partial M}{\partial z}}{\frac{\partial M}{\partial x}} \right] \tag{4}$$

The concept of an analytical signal comprising second-order derivatives of the total field, can be used in a manner similar to that used by Hsu *et al.* (1996). The Hilbert transform and the vertical-derivative operators are linear, so the vertical derivative of (3) will give the Hilbert transform pair,

$$\frac{\partial^2 M(x, z)}{\partial z \partial x} \Leftrightarrow - \frac{\partial^2 M(x, z)}{\partial^2 z} \tag{5}$$

Thus the analytical signal could be defined based on second-order derivatives, $A_2(x, z)$, where

$$A_2(x, z) = \frac{\partial^2 M(x, z)}{\partial z \partial x} - j \frac{\partial^2 M(x, z)}{\partial^2 z} \tag{6}$$

This gives rise to a second-order local wave number k_2 , where

$$k_2 = \frac{\partial}{\partial x} \tan^{-1} \left[\frac{\frac{\partial^2 M}{\partial^2 z}}{\frac{\partial^2 M}{\partial z \partial x}} \right] \tag{7}$$

The first- and second-order local wave numbers are used to determine the most appropriate model and depth estimate independent of any assumptions about a model.

Nabighian (1972) gives the expression for the vertical and horizontal gradient of a sloping contact model as:

$$\frac{\partial M}{\partial x} = 2KFc \sin d \frac{h_c \cos(2I-d-90) + x \sin(2I-d-90)}{h_c^2 + x^2} \quad (8)$$

$$\frac{\partial M}{\partial z} = 2KFc \sin d \frac{x \cos(2I-d-90) + h_c \sin(2I-d-90)}{h_c^2 + x^2} \quad (9)$$

Where K is the susceptibility contrast at the contact, F is the magnitude of the earth's magnetic field (the inducing field), $c = 1 - \cos^2 i \sin^2 \alpha$, α is the angle between the positive x-axis and magnetic north, i is the ambient-field inclination, $\tan I = \sin i / \cos \alpha$, d is the dip (measured from the positive x-axis), h_c is the depth to the top of the contact and all trigonometric arguments are in degrees. The coordinate system has been defined such that the origin of the profile line ($x = 0$) is directly over the edge.

The expression for the magnetic-field anomaly due to a dipping thin sheet is

$$M(x, z) = 2KF_{cw} S \frac{h_1 \sin(2I-d) - x \cos(2I-d)}{h_1^2 + x^2} \quad (10)$$

where w is the thickness and h_1 the depth to the top of the thin sheet. The expression for the magnetic-field anomaly due to a long horizontal cylinder according to Nabighian, M.N. (1984) is

$$M(x, z) = 2KFS \frac{\sin i (h_h^2 - x^2) \cos(2I-180) + 2xh_h \sin(2I-180)}{(h_h^2 + x^2)^2} \quad (11)$$

S is the cross-sectional area and h_h is the depth to the centre of the horizontal cylinder. Substituting (8), (9), (10) and (11) into the expression for the first- and second-order local wave number (K_1 & K_2) After some simplification yield a remarkable result (12) and (13) as were obtained.

$$k_1 = \frac{(n_k + 1)h_k}{h_k^2 + x^2} \quad (12)$$

and

$$k_2 = \frac{(n_k + 1)h_k}{h_k^2 + x^2} \quad (13)$$

Where n_k is the SPI structural index (subscript $k = c, t$ or h), and $n_c = 0$,

$n_t = 1$ and $n_h = 2$ for the contact, thin sheet and horizontal cylinder models, respectively.

From (12) and (13) above, it is evident that the first- and second-order local wave numbers are independent of the susceptibility contrast, the dip of the source and the inclination, declination, and the strength of the earth's magnetic field.

Results and Discussion

Qualitative trend analysis

Figure 3 is the total magnetic intensity map of the study area. It shows a colour range of total magnetic intensity anomalies of high and low magnetic intensity values which dominate northeast-southwest trends. The blank area in the map shows plain or missing data, the total magnetic intensity anomaly highs are dominant in the north-eastern, south-eastern and west-central part of the Bida Basin, while total magnetic intensity anomaly lows are dominant in the north, central and southern portions of the study area. Since sedimentary rocks have low susceptibility values, the observed magnetic high anomaly closures within the basin area may originate from the underlying basement rocks beneath the basin or from intrusive rocks which might have intruded into the basin section (Udensi et al., 2000). The resultant TMI map in Figure 3 comprises of high, low and intermediate magnetic signatures which could be attributed to (a) rock susceptibility (b) depth to the source magnetic rock (c) degree of strike and (d) remnant magnetization (Sunday, 2012).

Trend and lineation are the major information of qualitative analysis which are usually an indication of the features that give rise to faults and fractures (Udensi et al., 2003). In the study area, (Figure 3) shows a colour range of total magnetic intensity values, with pink as high and blue as low. The dominant trends is Northeast-Southwest trends and are observed around Mokwa area in the Northwest portion and around Pategi in the Southeast portion. Also, northeast-southwest trend is observed around Lafiagi in the central portion of the area. Several magnetic high and low dot the study area and are usually paired together. The high are concentrated on the Southeast direction while the low are concentrated on the northwest direction. It also shows that the area is composed of different magnetic region that are differentiated on the basis of variation of intensities of magnetic response. The North western part of the study area is characterized by high magnetic response, trending Northeast-Southwest. The North-Eastern part of the map is also characterized by high magnetic anomalies and lows magnetic anomalies trending East-west direction. Finally, the central part of the map represented by the blue colour is characterized by low magnetic response trending Eastwest and Northeast-Southwest direction represent Pan African trend. This is in accordance of the work carried out by (Buser, 1966). He established the existence of Paleostuctures which were due to tectonic movements, intrusion, metamorphism, sedimentation, mineralization, volcanism and drainage.

First Vertical Derivative

Figure 4 shows the lineament derived from the first vertical derivative map. Several lineaments were labelled from F1-F17. The southern part of the map is remarkably characterized by high distortion in the magnetic signatures which are signatures of basement regions. The central part is characterized by long wavelength anomalies which represent the sedimentary region. These lineaments have been interpreted as combinations of lithologic contacts, basement fault line. Most of the fault line and fractures identified within the study area are trending NE-SW and this is in conformity with the history of the formation of the Bida Basin (Udensi et al., 2003).

Correlation of First Vertical Derivative Map and Lineament Map

Figure 5 shows the correlation of first vertical derivative map and lineament maps on the basis of lineaments. The prominent trend directions common to both maps are the northeast-southwest and northwest-southeast directions. This is in agreement with Udensi *et al.*, (2003) and Ajakaiye *et al.*, (1991).

Source Parameter Imaging (SPI)

The result of the Source Parameter Imaging analysis of the aeromagnetic data over part of Bida Basin identified two main magnetic horizons under the area; the deeper sources are represented by the low frequency components while shallower magnetic sources are represented by the high frequency components (Figure 6a). The maximum thickness of sediment found in the study area is about 3.0 km. These areas are targets for hydrocarbon accumulation in the Bida Basin.

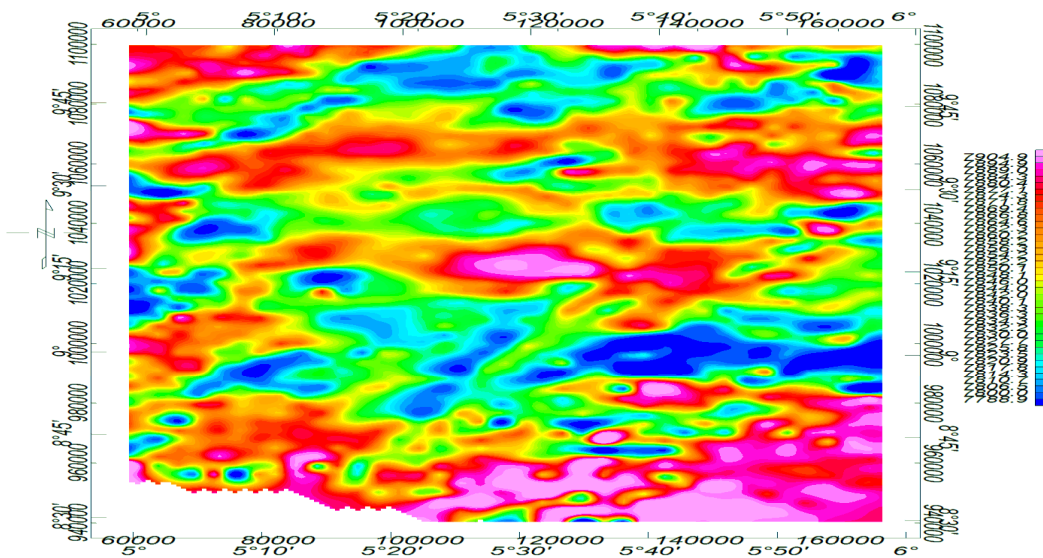
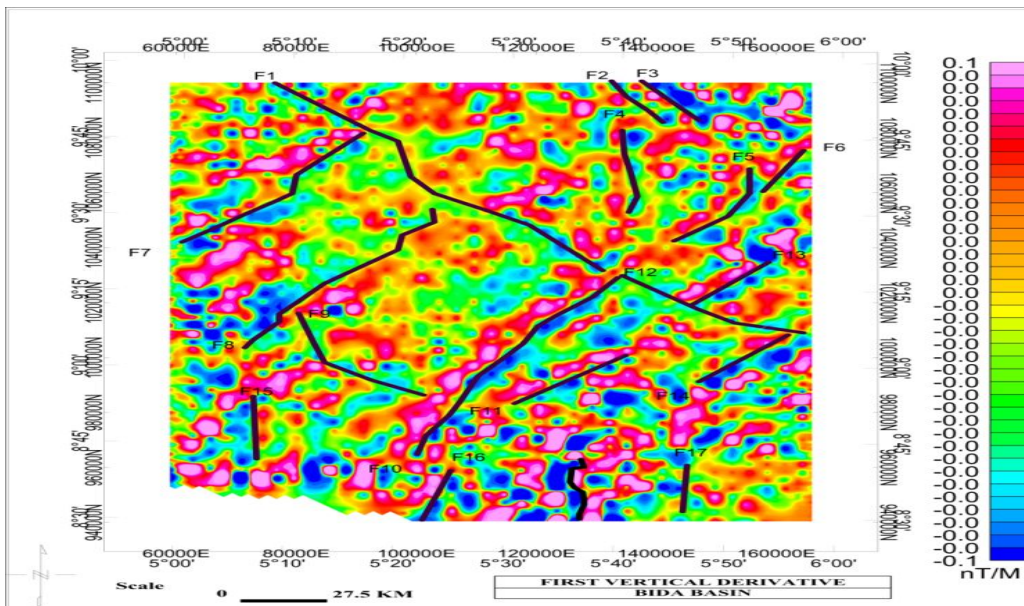


Figure 3: Total Magnetic Intensity Map of the Study Area after 25,000nT have Been Removed



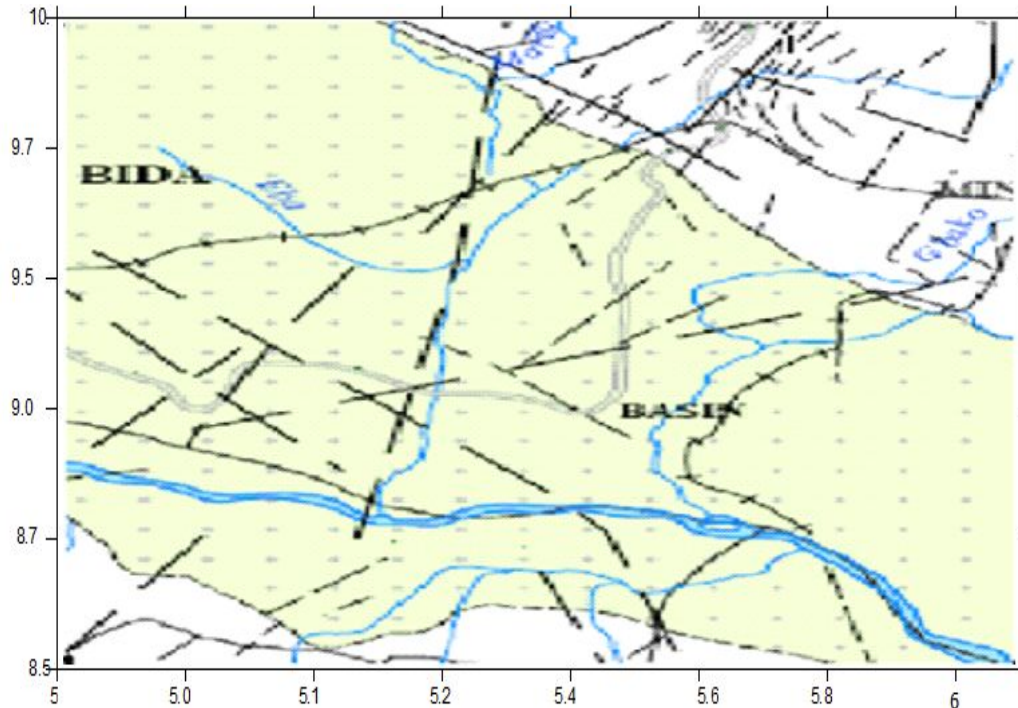
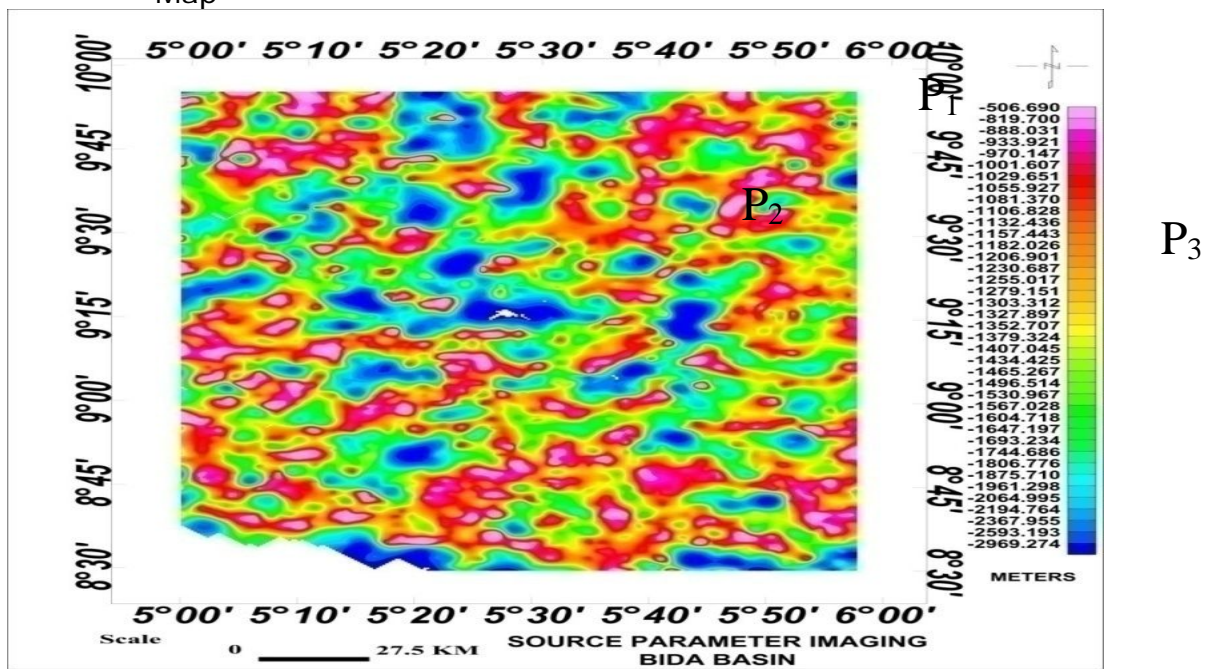


Figure 4: First Vertical Derivative Map of the study area. Figure 5: Lineament Map



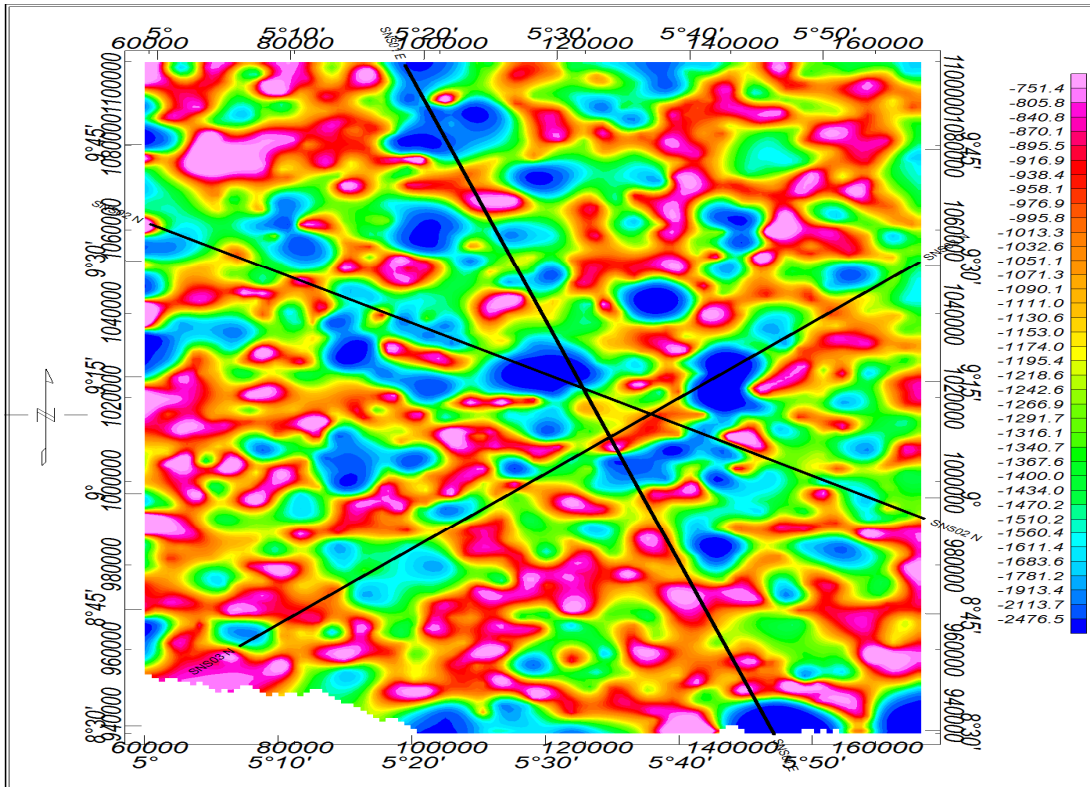


Figure 6(a): Source Parameter Imaging of the Study Area (b) SPI with Three Profile Lines

Three profiles were drawn across SPI Map, Figure 6b. These profiles were carefully drawn such that the areas of considerable sedimentary thicknesses were covered. Profile 1 (Figure 7a) was drawn in the direction of NNW-SSE. The profile has its highest sedimentary thickness of about 3.8 km at the edge of the profile. Profile 2 (Figure 7b) was drawn in the direction of NW-SE. The profile has its highest sedimentary thickness of about 4.0 km at the central portion of the profile. Profile 3 (Figure 7c) was drawn in the direction of SW-NE. The profile has its highest sedimentary thickness of about 3.5 km at edge of the profile. Profile 2 (Figure 7b) has the highest sedimentary thickness along Mokwa area in the NW portion and around pategi in the SE part of the study area.

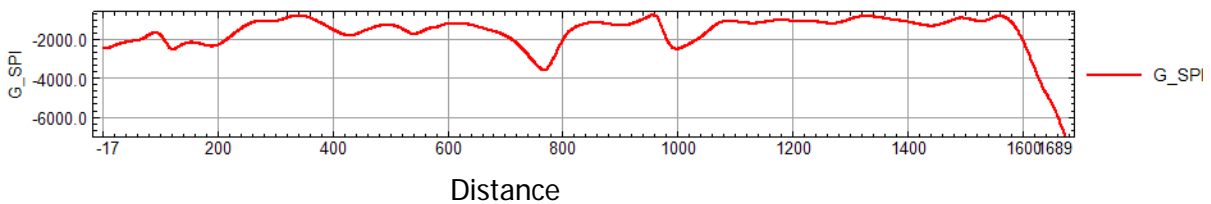


Figure 7a: Profile 1 drawn in NNW-SSE direction in Figure 6b

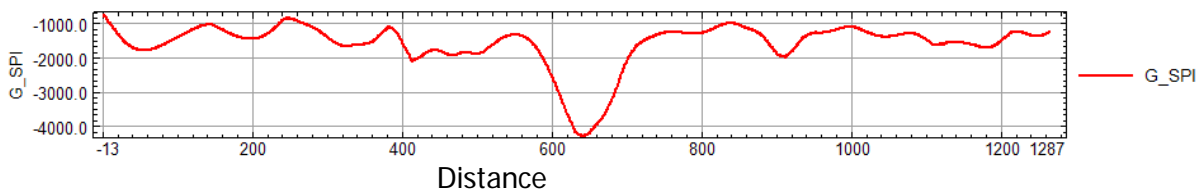


Figure 7b: Profile 2 drawn in NW-SE direction in Figure 6b

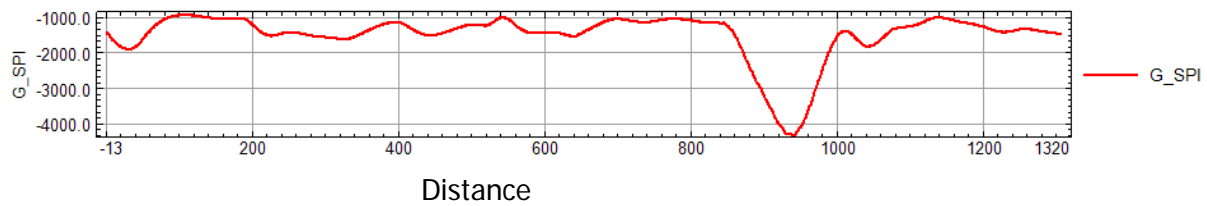


Figure 7c: Profile 3 drawn in SW-NE direction in Figure 6b

Conclusion

Investigation of Magnetic Trends using aeromagnetic map was carried out in the central part of the Bida Basin using Vertical Derivative, and Source Parameter Imaging. Analysis of the Total Magnetic Intensity map shows a combination of both high and low magnetic closures due to variation in intensity values. The highs, lows and intermediate magnetic signatures could be attributed to: (a) rock susceptibility, (b) depth to the source magnetic rock, (c) degree of strike and (d) remanant magnetization. The total magnetic intensity (TMI) data was reduced to equator.

The Aeromagnetic Data was analysed using the First Vertical Derivative analysis which represent sedimentary region with several lineaments labelled as F1-F17. These lineaments have been interpreted as combinations of lithological contacts, and basement fault line. Most of the fault line and fractures identified within the study area are trending NE-SW and this is in conformity with the history of the formation of the Bida basin. The economic mineral present in the study area may be found along the lineaments delineated, since most magnetic minerals are structurally controlled.

The result of the Source Parameter Imaging analysis identified two main magnetic horizons under the area, the deeper sources are represented by the low frequency sources while shallower magnetic sources are represented by the high frequency sources and the thickness of sediment of about 3.0 km is found in the south and central part of the study area. These areas are targets for the hydrocarbon accumulation in the Bida Basin and therefore recommended for seismic survey and borehole logging for further investigation.

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PALYNOLOGICAL AND CALCAREOUS NANNOFOSSIL BIOSTRATIGRAPHY OF OM-4 AND OM-A WELLS, WESTERN NIGER DELTA, NIGERIA

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Abstract

*Palynological and calcareous nannofossil analyses were carried out on 50 ditch cutting samples each from two wells OM-4 and OM-A, western Niger Delta, Nigeria with the aim of establishing their biozones. Studied intervals in both wells ranged from 8200 – 11350 ft. Acid method was used for palynomorph processing while smear slide method was used for calcareous nannofossil. The palynomorphs yielded 51 and 44 species in OM-4 and OM-A wells respectively while the calcareous nannofossils had a poor yield of 1 species in OM-4 well and 17 species in OM-A well. Based on the contained diagnostic marker palynomorphs and calcareous nannofossils present in the wells, three palynomorph zones, *Retibrevitricolporites protudens/obodoensis* – *Verrutricolporites* sp Zone (T1), *Monocolpites* sp – *Magnastriatites howardi* Zone (T2) and *Crassoretitriletes vanraadshooveni* Zone (T3) were identified in OM-4 well, while an indeterminate Zone (T4), *Peregrinipollis nigericus* – *Cyperaceaepollis* sp Zone (T5) and *Psilatiriporites* sp – *Retitricolporites* sp Zone (T6) were identified for the OM-A well. The informal T1, T2 and T3 zones established in OM-4 well corresponded to the P650, P670-P680 and P720 subzones. Also, the three zones, T4, T5 and T6 established in OM-A well, corresponds to the P830, P840 and P850 subzones and the *Echitricolporites spinosus* pan tropical palynological zone. No calcareous nannofossil zone was established in OM-4 well due to very poor recovery, while *Discoaster quinqueramus* – *Discoaster berrigrenni* Zone (NN11) was identified in OM-A well. The wells were assigned Miocene Epoch based on the presence of Miocene markers.*

Keywords: *Biozones, Diagnostic marker, Palynomorphs, Miocene.*

Introduction

The use of palynomorphs and calcareous nannofossils in present day studies based on their characteristics which include their rapid diversification, considerable resistance to obliterations by acids, ease to process and their abundance have made them relevant in biozonation and correlation, paleoenvironmental and paleoclimatic studies and biochronology of strata. This has encouraged the use of these fossils to carry out a detailed biostratigraphic study of OM-4 and OM-A wells. This study is aimed at carrying out a palynological and calcareous nannofossil biostratigraphy of OM-4 and OM-A wells by identifying the palynomorphs and calcareous nannofossils present in the strata penetrated by the two wells and establishing biozones based on palynomorphs and calcareous nannofossil assemblages for the strata penetrated.

Location and Geology of the Study Area

The Niger Delta lies between latitude 4° and 7°N and longitudes 3° and 9°E in the southern part of Nigeria. The studied OM-4 and OM-A wells are located on the onshore part of the Niger Delta, on latitude 4°38' N and longitude 6°48'0 N and 4°37'E and 6°47'E respectively (Figure 1). The Niger delta basin contains sediments of Paleogene to Holocene which are deposited in high energy deltaic environment. These formations are basically laid in three lithostratigraphical order which include Benin Formation, Agbada Formation and Akata. Both wells fall within the Agbada formation within the coastal swamp depobelt.

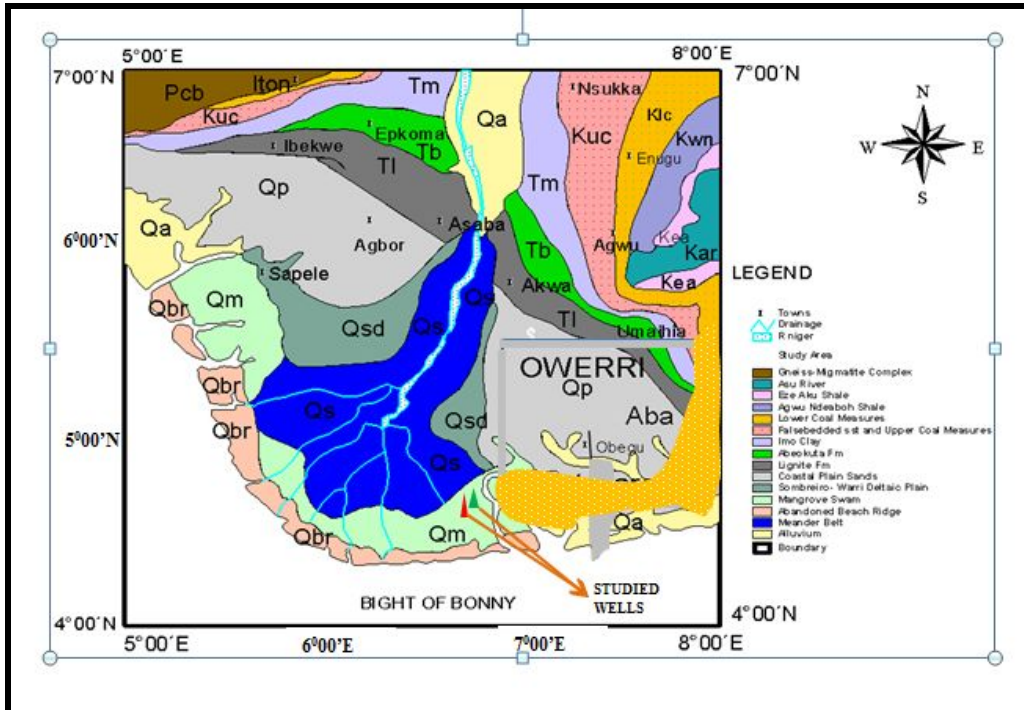


Figure 1: Geological map of Niger Delta showing the location of the studied wells (Modified after Knox & Omotasola, 1990)

Materials and Methods

Ditch cuttings and well logs (Gamma ray and sp logs) were given by Chevron Nigeria Plc. 50 ditch cutting samples collected at depth intervals of 30 ft from each well between intervals of 8200 ft to 11400 ft were studied in both wells respectively. Lithology logs were generated from the well logs showing varying lithologic units ranging from silty shale to shales to sandstone.

Preparation of the palynologic samples were done using standard procedures that involved labeling (The sample names were coded for proprietary reasons), cleaning and weighing of the samples, followed by complete digestion of the samples in hydrochloric and hydrofluoric acid for the removal of carbonates and silicates respectively. The palynomorphs were counted on each of the two slides prepared per sample. The slides were viewed under the binocular microscope (National) at a magnification of X400 in Mosunmolu Nigeria Limited laboratory, Lagos, Nigeria. Forms observed were identified and named using palynological albums as well as descriptions of previous workers (Germeeraad *et al.*, 1968; Evamy *et al.*, 1978; Adegoke *et al.*, 1986). The identified species were noted, counted and recorded on the analysis sheet using the tally system. The process was repeated for all the slides. The results were inputted into the stratabug software (2011) to prepare the palynomorphs distribution chart.

Calcareous nannofossils were recovered using the smear slide method. This was achieved by scraping about 5 g of the sample on a glass cover-slip and adding drops of distilled water to make a thick sediment suspension which was smeared thinly across the surface of the cover slip with a flat tooth pick, and placed on a hot plate to dry rapidly. A glass slide was affixed over the cover-slip using optical adhesive medium. The slides were viewed under the microscope for calcareous nannofossil identification using the binocular microscope (Meiji Techno) at a magnification of X1000, also at Mosunmolu Nigeria Limited laboratory, Lagos. The species identification was done using calcareous nannofossils albums as well as

descriptions of previous workers (Martini, 1971; Okada & Bukry, 1980; Ajayi & Okosun, 2012).

Result and Discussion

Recovery of palynomorphs was good from both wells in terms of abundance, diversity and preservation at all depth (Figures 2 and 3) but was extremely poor for calcareous nannofossils, showing a lone species occurrence in OM-4 well and low abundance and diversity at two depths in OM-A well (Figures 4 and 5).

Palynomorph Distribution

The distribution of palynomorphs, (pollen, spores, dinoflagellates and algae) in the studied section varied from one depth to another in diversity and abundance. Pollen and spore preservation was fair in both wells with total species count of fifty-one and forty-four in OM-4 and OM-A wells respectively. The lists of the forms of palynomorphs as recovered from the ditch cuttings from both wells as plotted on the charts are as follows:

- (i) *Pollen and Spores*: *Zonocostites ramonae*, *Laevigatosporites* sp., *Monoporites annulatus*, *Cypereapollis* sp, *Peregrinipollis nigericus*, *Gemmamonoporites* sp, *Pachydermites diderixi*, *Psilatricolporites crassus*, *Racemonocolpites hians*, *Retibrevitricolporites protudens/obodoensis*, *Retitricolporites irregularis*, *Sapotaceoidaepollenites* sp, *Striatricolpites catatumbus*, *Tricolporite* sp, *Verrustephanocolpites complanatus*, *Verrutricolporites rotundiporus*, *Podocarpus* sp, *Acrostichum aureum*, *Crassoretitriteles vanraadshooveni*, *Magnastriatites howardi*, *Polypodiceoisporites* sp, *Selaginella myosurus*, *Verrucatosporites* sp, *Lycopodiumneogenicus*, *Magnastriatites* sp, *Alnus vera*, *Canthiumidites* sp, *Chenopodiaceae* sp, *Alnipollenites verus*, *Stereisporites* sp, *Charred gramineae cuticle*, *Fungal spores and hyphae*, *Inaperturopollenites* sp, *Monocolpites* sp, *Praedapollis flexibillis*, *Praedapollis* sp, *Proteacidites cooksonni*, *Bombacacidites* sp, *Ctenolophonidites costatus*, *Psilastephanocolporites minor*, *Retitricolporites bendeensis*, *Belskipollis* sp, *Corsnipollenites jussiaeensis*, *Echistephanoporites echinatus* and *Spirosyncolpites bruni*
- (ii) *Dinoflagellates*: *Leiosphaeridia* sp, *Dinocyst indeterminate*
- (iii) *Algae*: *Botryococcus braunii*

Calcareous Nannofossil Distribution

The ditch cuttings analysed for calcareous nannofossils from both wells yielded poor recovery in both abundance and diversity. OM-4 well contained a lone species, *Coronocylus nitescens* at depth 6430 ft while a total of 17 species, *Discoaster quinquerramus*, *Discoaster bergrenii*, *Calcidiscus leptoporus*, *Calcidiscus tropics*, *Discoaster brouweri*, *Discoaster exillis*, *Discoaster loeblichii*, *Discoaster pentaradiatus*, *Discoaster* sp, *Discoaster variabilis*, *Helicosphaera carteri*, *Pontosphaera multipora*, *Reticulofenestra pseudoumbilicus*(5-7" and 7"), *Sphenolithus abies* and *Sphenolithus moriformis* were recovered in OM-A well. Highest diversity of the species occurred at 8440 ft, lone occurrence at 9760 ft.

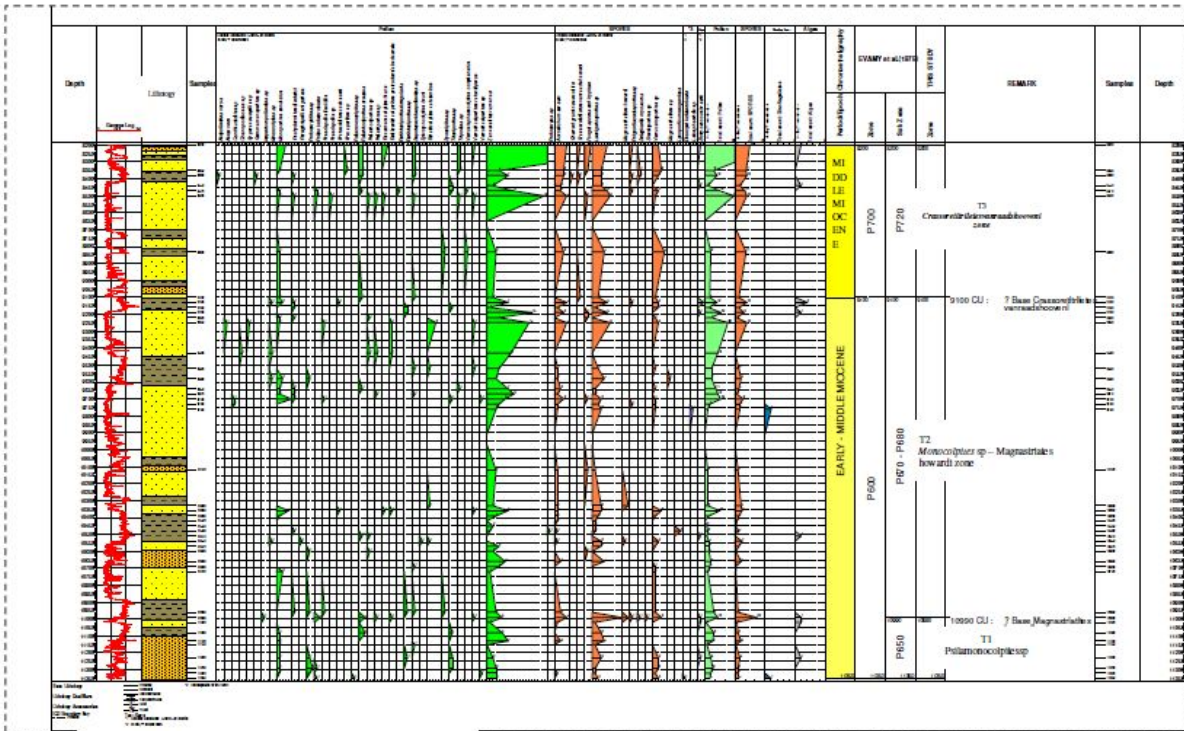


Figure 2: Palynomorph Distribution of OM-4 well

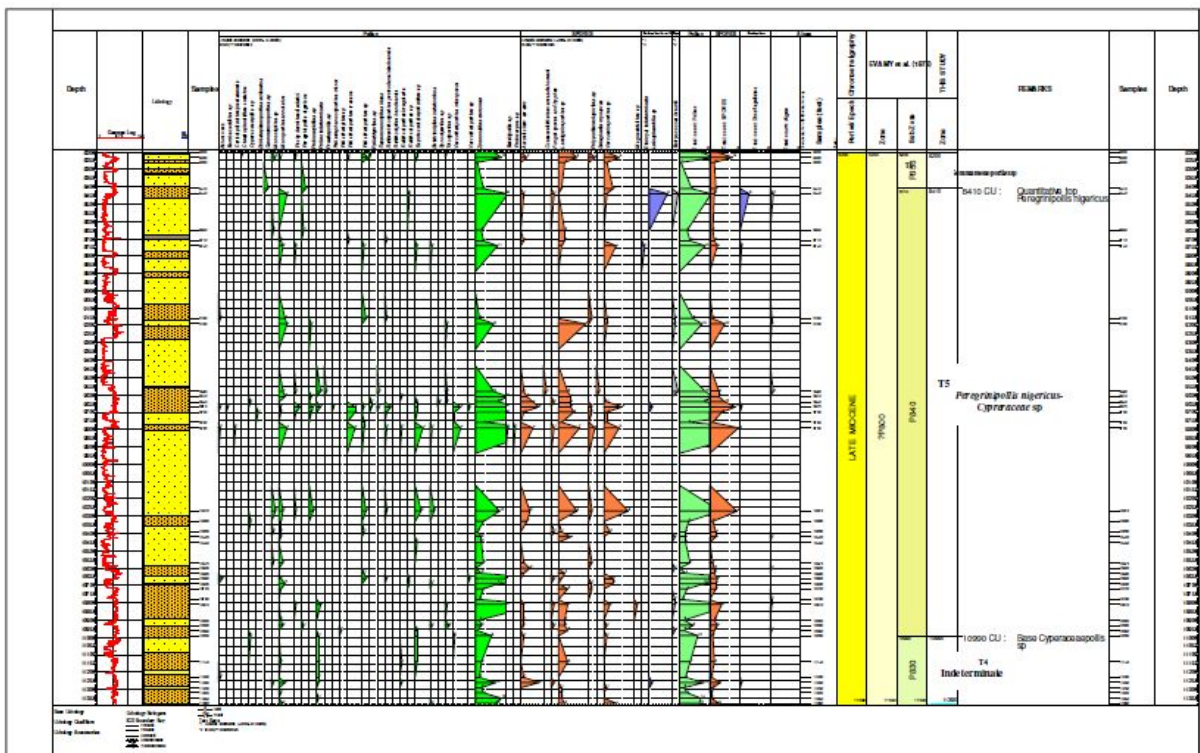


Figure 3: Palynomorph Distribution of OM-A well

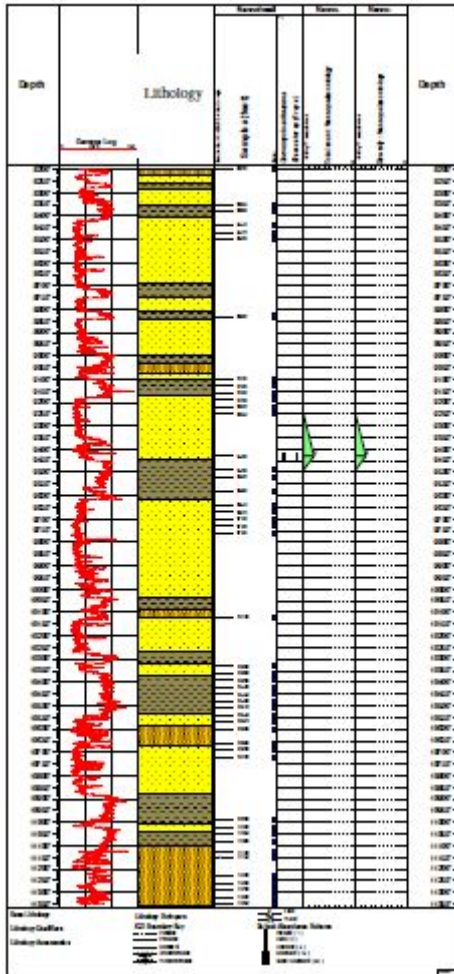


Figure 4: Calcareous Nannofossils Distribution of OM-4 well

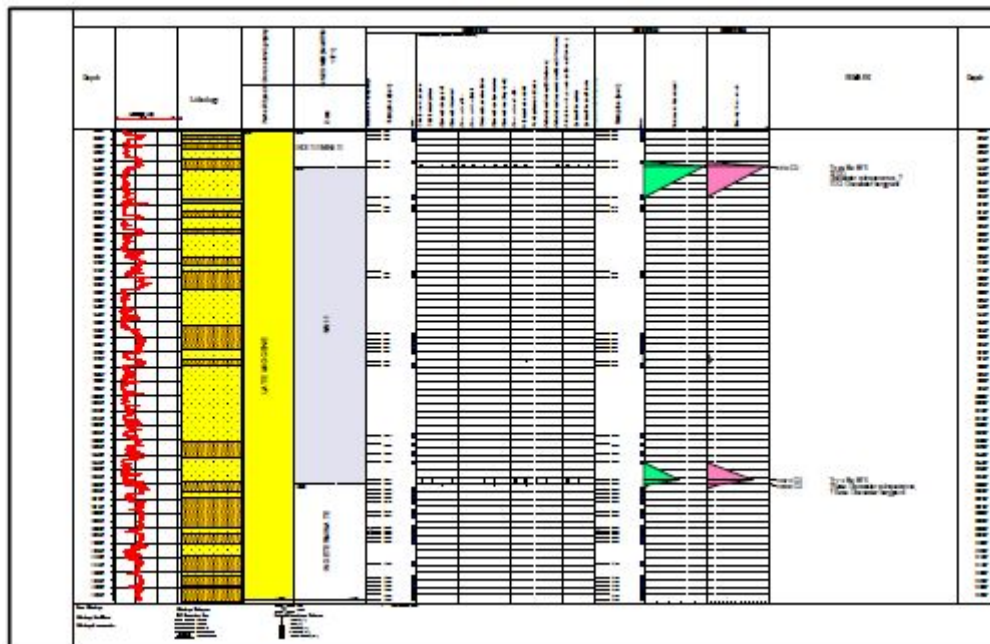


Figure 5: Calcareous Nannofossils Distribution of OM-A well

Palynomorph Biozonation

Palynomorph biozonations for both wells were defined by the first downhole occurrence (FDO) and last downhole occurrences (LDO) of one or more stratigraphically important species in accordance to the International Stratigraphic Guide (Murphy & Salvador, 1999). Three informal biozones introduced as T3, T2 and T1 biozones were proposed in OM-4 and T6, T5 and T4 were proposed in OM-A well. The three biozone types established are the taxon range zone, concurrent range zone and interval zone.

ZONE T1: *Retibrevitricolporites protudens/obodoensis* – *Verrutricolporites* sp Zone

Zone type: Interval zone

Depth: 11350 - 10990 ft

Age: Early Miocene

This is an interval zone which has its base marked by the LDO of *Verrutricolporites* sp at 11350 ft and the top by the LDO of *Retibrevitricolporites protudens/obodoensis* at 10990 ft, both species having their only occurrences at these depths. The associated species within this zone are: *Monoporites annulatus*, *Zonocostites ramonae*, *Podocarpidites* sp, *Retitricolporites* sp, *Sapotaceoidaepollenites* sp, *Tricolporite* sp, *Psilamonocolpites* sp, *Stereisporites* sp, *Acrostichum aureum*, *Laevigatosporites* sp, *Verrucatosporites* sp, *Botryococcus braunii*, *Psilatirporites* sp. This zone corresponds with the P650 of (Evamy *et al.*, 1978) which has the top of the zone marked with the LDO of *Magnastriatites howardi*.

ZONE T2: *Monocolpites* sp – *Magnastriatites howardi* Zone

Zone type: Concurrent range zone

Depth: 10990 - 9100 ft

Age: Early Miocene

This zone is marked at the base by the LDO of *Magnastriatites howardi* at 10900 ft and at the top by the FDO of *Monocolpites* sp at 9100 ft. Other associated species within the zone are *Pachydermites diderixi*, *Spirosyncolpites* sp, *Striatricolpites catatumbus*, *Podocarpus* sp, Fungal spores and hyphae, *Magnastriatites* sp, *Retibrevitricolporites protudens/obodoensis*, *Psilatricolporites crassus*, *Verrutricolporites rotundiporis*, *Praedapollis flexibillis*, *Proteacidites cooksonni*, *Polypodiaceoisporites* sp, *Selaginella myosurus*, *Stereisporites* sp and *Leiosphaeridia* sp (dinoflagellate). This zone corresponds with (Evamy *et al.*, 1978) P670 - P680 zone which is marked at the top by LDO of *Crassoretitriletes vanraadshooveni* at the base by LDO of *Magnastriatites howardi*.

ZONE T3: *Crassoretitriletes vanraadshooveni* Zone

Zone type: Taxon range zone

Depth: 9100-8200 ft

Age: Middle Miocene

The zone is a taxon-range zone marked at the base and the top by the LDO and FDO of *Crassoretitriletes vanraadshooveni* at 9100 ft and 8200 ft. Other associated species within the zone include *Alnipollenites verus*, *Gemmamonoporites* sp, *Praedapollis* sp, *Proxapertites* sp, *Psilatricolporites* sp, *Psilatirporites* sp, *Racemonocolpites hians*, *Retitricolporites irregularis* and *Verrustephanocolpites complanatus*. This zone corresponds with the P720 of (Evamy *et al.*, 1978), as it is bounded at the base by LDO of *Crassoretitriletes vanraadshooveni*.

ZONE T4: Indeterminate Zone

Depth: 11350 – 10990 ft

The zone was marked as "indeterminate" because there were no marker species occurring within the zone. This zone corresponds with that of (Evamy *et al.*, 1978) P830 subzone as it is bounded at the top by the LDO of *Cyperaceaepollis* sp, which marks the base of P840 and the top of P830.

ZONE T5: *Peregrinipollis nigericus*- *Cyperaceaepollis* sp Zone

Zone type: Concurrent range zone

Depth: 10990 – 8410 ft

Age: Late Miocene

The base is marked by the LDO of *Cyperaceaepollis* sp at 10990 ft and the top of the zone by the quantitative FDO of *Peregrinipollis nigericus* at 8410 ft. Also marking the top of the zone is the LDO of *Gemmamonoporites* sp, while those marking the base of the zone are the LDO of *Verrutricolpites microporus*. Other species associated with the zone are *Monocolpites* sp, *Monoporites annulatus*, *Psilatricolpites* sp, *Pachydermites diederixi*, *Retitricolpites* sp, *Podocarpidites* sp, Pollen indeterminate, *Praedapollis* sp, *Psilastephanocolpites minor*, *Laevigatosporites* sp, *Polypodiaceoisporites* sp, *Selaginella myosurus*, *Verrucatosporites* sp, *Leiosphaeridia* sp and *Botryococcus braunii* (algae).

This zone corresponds with the P840 subzone of (Evamy *et al.*, 1978), which has the top marked by *Peregrinipollis nigericus* and at the base by *Cyperaceaepollis* sp.

ZONE T6: *Psilatriporites* sp - *Retitricolporites* sp Zone

Zone type: Interval zone

Depth: 8410 – 8200 ft

Age: Late Miocene

The zone is an interval zone marked at the top by the FDO of *Psilatriporites* sp at 8200 ft and at the base by the FDO of *Retitricolporites* sp, at 8410 ft. Other long ranging species running through the zone include: *Monocolpites annulatus*, *Psilatricolpites* sp, *Retitricolporites bendeensis*, *Sapotaceoidaepollenites* sp, *Tricolpites* sp, *Zonocostites ramonae*, *Acrostichum aureum*, *Laevigatosporites* sp, *Polypodiaceoisporites* sp, *Verrucatosporites* sp. The zone corresponds to pollen zone P850 of (Evamy *et al.*, 1978) which has its base marked by the FDO of *Peregrinipollis nigericus*.

Table 1: Summary of Palynomorph Biozonation in both wells

Depth	Age	Palynomorph Zone and name (Present Study)	Informal Zone	Evamy <i>et al.</i> , 1978 zones	Well	Biozone Type
9100-8200 ft		<i>Psilatriporites</i> sp- <i>Retitricolporites</i> sp	T6	P850		Interval
10990-9100 ft	Late Miocene	<i>Peregrinipollis nigericus</i> – <i>Cyperaceaepollis</i> sp	T5	P840	OM-A	Concurrent Range
11350-10990 ft		Indeterminate	T4	P830		Indeterminate
9100-8200 ft	Middle Miocene	<i>Crassoretitriletes vanraadshooveni</i>	T3	P720		Taxon
10990-9100 ft		<i>Monocolpites</i> sp – <i>Magnastriates howardi</i>	T2	P670-P680		Concurrent
11350-10990 ft	Early Miocene	<i>Retibrevitricolporites protudens/obodoensis</i> – <i>Verrutricolporites</i> sp	T1	P650	OM-4	Interval

Calcareous Nannofossils Biozonation

Diagnostic marker species within the wells formed the basis for biozonations for both wells. It is important to note that the poor yield of nannofossils made the division impossible in OM-4 well and broad in OM-A well.

The entire OM-4 well was completely barren of calcareous nannofossil except at 9430 feet where a lone occurrence of *Coronocyclus nitescens* (which is long ranging species), was recorded. This made biozonation of calcareous nannofossil impossible in this well.

Recovery of calcareous nannofossils from OM-A well gave the total species count of seventeen (17) as seen in figure 4. Based on the assemblages of diagnostic species and notable nannofossil events, the FDO and LDO of 2 diagnostic species, *Discoaster quinqueramus* and *Discoaster berggrenii* at 8440 ft and 10600 ft was used to mark the top and the base of the zone. This zone corresponds with NN11 zone of (Martini, 1971), CN 9a and 9b of (Okada & Bukry, 1980) and NN11a and b subzones of (Ajayi & Okosun, 2012).

Conclusion

Six palynomorph zones (T1-T3 in OM-4 well and T4-T6 in OM-A well) were proposed in both wells and they correspond to the already established pollen zones of Evamy *et al.*, 1978. These are *Retibrevitricolporites protudens/obodoensis*– *Verrutricolporites* sp Zone (T1), *Monocolpites* sp – *Magnastriatites howardi* Zone (T2) and *Crassoretitriletes vanraadshooveri* Zone (T3) in OM-4 well, while an indeterminate Zone (T4), *Peregrinipollis nigericus* – *Cyperaceapollis* sp Zone (T5) and *Psilatirporites* sp – *Retitricolporites* sp Zone (T6) were identified for the OM-A well. The informal T1, T2 and T3 zones established in OM-4 well corresponded to the P650, P670-P680 and P720 subzones of Evamy *et al.*, 1978. Also, the three zones, T4, T5 and T6 established in OM-A well, correspond to the P830, P840 and P850 subzones of (Evamy *et al.*, 1978). Zones established by previous workers (Olajide *et al.*, 2012; Adeigbe, 2013; Jennifer *et al.*, 2014) which corresponds to the pollen zones within which these informal zones fall, have been used mainly in age determination and paleoenvironmental interpretations. No calcareous nannofossil zone was established in OM-4 well due to very poor recovery while *Discoaster quinqueramus* – *Discoaster berrgrenni* Zone (NN11) was identified in OM-A well which depth ranges did not have a clear correlation with any of the palynomorph zones.

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AN ASSESSMENT OF ELECTRONIC RESOURCES AND UTILIZATION IN UNIVERSITIES OF NORTH CENTRAL NIGERIA

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Abstract

The study examined the availability, purpose and extent of the utilisation of electronic resources in universities of North-Central Nigeria. It aimed at finding out the available electronic resources, extent of utilisation, reasons of utilising electronic resources and purpose of utilising electronic resources. The population of the study was made up of 2,361 postgraduate students. The study adopted descriptive survey research design using a Multi stage sampling technique. A structured questionnaire was used to collect data from 331 postgraduate students. Mean and standard deviation were used to analyse the data collected. Findings of the study revealed that electronic books and electronic databases were the most available electronic resources, although the utilisation of these resources was low among postgraduate students in universities of North-Central Nigeria. The study recommended increased investment in Information and Communication (ICT) facilities to promote increase utilisation of electronic resources by postgraduate students in North-Central Nigerian universities.

Keywords: *Assessment, Electronic resources, Utilization, Universities, Information resources*

Introduction

Universities are established to provide research, teaching and community services to its host communities. Universities are higher institutions of learning that awards undergraduate and postgraduate degree to its students. In order for a university to function properly its need a functional library that will provide the needed information resources which will serve as a backbone to meet the information needs of its students and staff.

Information resources are sources from where information is gotten to meet the needs of the university community. With the advent of Information and Communication Technology (ICT) these sources are now in electronic formats termed as electronic resources, digital library resources or electronic information resources.

Electronic resources are information sources in digital formats that are accessed over a network with the aid of an electronic device like computer. Electronic information resources include e-journal, e-books, e-newspapers, e-theses and dissertations. Thanuskodi (2012) identified electronic resources as sources of information in electronic formats accessed via the internet. Dhanavadan, Esmail and Nagarajan (2012) corroborated the above view when they opined that electronic resources are of different forms which are available on the internet with e-journal and e-books the most used.

In this study, utilisation of electronic resources is the extent to which postgraduate student use these sources of information and for what purposes they use them. It is important for students to maximise the use of the available resources in order to improve their academic work. Emwanta and Nwalo (2013) reported that electronic resources could enhance the

learning process of students by providing relevant information for their academic work. Furthermore, electronic resources are used for research, teaching purposes, preparation for presentation and conferences. The use of these sources of information is aided by information and communication technology infrastructure in universities of North Central Nigeria. It is against this backdrop that the study intends to identify the available electronic resources in universities of North central Nigeria, the extent of utilization and the reason why postgraduate student use these sources of information.

Statement of the Problem

Universities in North-Central Nigeria are subscribing and purchasing electronic resources due to advancement of information technology and in order to meet the information needs of the students and faculty members. Libraries are benefiting from the attributes associated with the use of these resources as such electronic resources have become an integral part of library collections. Electronic resources are complementing their print counterpart.

Despite these benefits attributed to the use of these resources they are still report cases to low access and use of electronic resources. This situation indicates more efforts needs to be done to determine the extent of utilization of these resources among postgraduate students in North Central Nigerian universities. It is against this backdrop that the study intends to assess electronic resources and its utilisation by postgraduate students in universities of North-Central Nigeria.

Objectives of the Study

The general objective of this study was to assess electronic resources and utilisation in universities in North-Central Nigeria. Specifically, the study was designed to:

- (i) Identify the available electronic resources in universities in North-Central Nigeria
- (ii) Identify the extent of utilisation of electronic resources by postgraduate students in universities North Central Nigeria.
- (iii) Determine the reason for utilising electronic resources by postgraduate students in universities of North-Central Nigeria.
- (iv) Ascertain the purpose of utilisation of electronic resources by postgraduate students in universities in North-Central Nigeria.

Research Questions

The following research questions guided the study:

- (i) What are the available electronic resources in universities in North-Central Nigeria?
- (ii) What is the extent of utilisation of electronic resources by postgraduate students in universities in North-Central Nigeria?
- (iii) What is the reason for utilising electronic resources by postgraduate students in universities in North-Central Nigeria?
- (iv) What is the purpose of utilisation of electronic resources by postgraduate students in universities in North-Central Nigeria?

Literature Review

Dongardive (2015) identifies electronic resources as those materials that require computer access through mainframe computer or handheld devices. Parameshwar and Patil, (2009); Swain (2010) found that electronic resources include e-journals, e-books, online databases, e-theses/e-dissertations, electronic references documents, CD-ROMs databases. From literatures, it was discovered that out of the different types of electronic resources, electronic journals and electronic books are the commonly used types of electronic resources.

Library users need not visit the library before they can access these sources of information. Access is no longer restricted to the walls of the academic libraries with the aid of internet; personal computers and hand held devices like the tablet and mobile phones users can now access the library's electronic resources. Postgraduate students at Madurai Kamaraj University used the library's subscribed electronic resource through the UGC-Infonet consortium (Thanuskodi, 2011). Access to electronic resources could be through consortium agreement and personal or university subscribed access as reported by (Adetoro, 2013). The same case can be said of Nigeria University Library. Consortium of Nigeria University Libraries (NUBLIB) have subscribed to EBSCOhost, Access to Global Online Research in Agriculture (AGORA), Health Internetwork Access to Research Initiatives (HINARI), Online Access to Research in the Environment (OARE) and other offline database like MEDLINE which could be accessed through the university library gateway (Annuobi & Okoye, 2008), though the major sources of access to electronic resources is through the institutional subscription (Khan, 2012). Postgraduate students at University Libraries of Tirupati when asked to identify their preferred location of access of electronic sources, 85.55% of the respondents chose the library, while the remaining accessed it from computer centres on campus, departments and other places (Konoppa, 2014). The responses of users in as to where they accessed electronic resources showed that it was evident that majority of postgraduate students at North Eastern Hill University Shilong, accessed electronic resources in the library, as against going to the cybercafé, department, hostel, computer centre (Naga & Sten, 2012). Furthermore, Obaje and Camble (2008), found that CD-ROMs are frequently used for literature searches during project/dissertation and thesis writing as well as personal research by staff.

Adeniran (2013) undertook a survey on the use of electronic resources by undergraduates focusing on the extent of awareness of electronic resources, the types of electronic resources available and the impact of electronic resources on the academic performances of undergraduate students.

Ajebomogun and Fagbola (2015) reported that postgraduate students at University of Agriculture Abeokuta utilise electronic resources majorly for research purposes because it easily provides access to the relevant materials needed to help in their work and in literature search. In a similar view, it was found that majority of respondents use electronic sources of information for research. About 29.4% use it to prepare lectures and 24.8% for knowledge acquisition (Ansari and Zuberi, 2010). However, it was found that in some selected private universities in Bangladesh, students use electronic resources for research purpose with a few of them using it for entertainment purposes (Mostofa, 2013). In support of Mostofa, investigations on the use of digital library sources by scholars in Banara Hindu University reveals that scholars use electronic sources for research (88%), 38% for writing articles, (30%) to search for important literatures in their subject field and (22%) to keep abreast with latest trends of information (Shukla & Mishra, 2011).

Research Methodology

This study adopted a descriptive survey research design. Multistage sampling technique was used to arrive at the desired sample size. The population of the study was 2,361 postgraduate students from the four selected faculties of the government owned universities of North-Central Nigeria (University of Ilorin, University of Agriculture Makurdi, Federal University of Technology Minna, Kwara State University Malete and Ibrahim Badamasi Babangida University Lapai). The sample size of the study was 331 obtained for Morgan and Krejcie estimation table. The sample was distributed proportionately using 30%, 25%, 20%, 15% and 10% respectively amongst the selected universities based on the population of postgraduate students in each university. A structured questionnaire was used to collect

data from respondents. Frequency counts and percentages were used to analyse the results. The study used a four point Likert scale type of questionnaire: Strongly Agree (S.A = 4), Agree (A = 3), Disagree (D = 2) and Strongly Disagree (S.D = 1). The rating scale in terms of the means score of 2.50 and above was considered adequate while below 2.50 was regarded as inadequate.

Results and Discussion

A total of three hundred (331) copies of the questionnaire were administered to postgraduate students in the selected universities. Out of this number, two hundred and seventy-four (274) copies of the questionnaire representing 83% were properly filled and returned for the analysis while fifty-seven (57) representing 17% were not returned. The overall response rate was 83% with the respondents from University of Agriculture Makurdi returned 82(83%) of the questionnaire, University of Ilorin returned 65(78%), Federal University of Technology Minna returned 57(86%), Kwara State University Malete returned 39(78%) and Ibrahim Badamasi Babangida University Lapai returned 31(94%) of the total copies of the questionnaire. The distribution of respondents by faculties is indicated in Tables 1.

Table 1: Distribution of respondents by faculties

Faculties	N	%
Law	10	3.6
Health Science	9	3.3
Life science	36	13.1
Management science	123	44.9
Physical science	13	4.7
Environment technology	17	6.2
Engineering technology	20	7.3
Veterinary medicine	3	1.1
Agronomy	12	4.4
Food technology	11	4.0
Natural science	2	0.7
Language and communication	1	0.4
Nimasa	3	1.1
Humanities, management and social science	8	2.9
Pure and applied science	2	0.7
Information and Communication Technology	1	0.4
Education	3	1.1
Total	274	100

Table 1 indicated that 72(26%) being the majority of respondents were from faculty of management science, followed by (9%) of the respondents from faculties of Life Science and Engineering technology. Data further revealed that 21(8%) of respondents were from faculty of Agronomy, (5%) of respondents from faculties of Physical sciences, Food technology, NIMASA, Humanities, management and social sciences respectively, 11(4%) from Environment technology, furthermore, (3%) from faculties of law, health science, veterinary medicine and pure and applied sciences respectively and lastly, 2(%) of respondents from faculties of Information and communication technology, Language and communication and natural sciences respectively.

Table 2: Types of electronic resources

S/N	Types of electronic resources	A	NA
1	Electronic journal	210(77%)	64(23%)
2	Electronic books	213(78%)	61(22%)
3	Electronic thesis and dissertation	135(49%)	139(51%)
4	Electronic databases	213(78%)	61(22%)
5	Electronic newspapers	164(60%)	110(40%)

Key: A = Available, NA = Not Available

Table 2 provides the types of electronic information resources available to postgraduate students in the library. Majority of respondents that is 213(78%) indicated that electronic books are the most available while 64(23%) of respondents stated that electronic books are not available. Moreover, 213(78%) and 61(22%) of respondents are of the view that electronic databases are available and not available respectively, 210(77%) and 64(23%) of respondents revealed that electronic journals are available and not available respectively in the library. Furthermore, 164(60%) of respondents indicated that electronic newspapers are available 164(60%) and 110(40%) of respondents indicated that electronic newspapers are not available. It was observed that postgraduate students in universities of North-Central Nigeria reveal that electronic journal, electronic books, electronic databases and electronic newspaper available based on their respective percentage. The same table shows that respondents stated that electronic thesis and dissertation 135(49%) and 139(51%) are available. Table 2 evidently shows that electronic books and electronic journals are the most available with electronic thesis and dissertations less available as result of most theses are still more in printed formats.

Table 3: Extent of utilization of electronic resources

S/N	Statements	\bar{X}	S.D
1	I use electronic resources daily	2.41	1.00
2	I use electronic resources once in a week	2.33	0.92
3	I use electronic resources twice a week	2.57	0.93
4	I use electronic resource monthly	2.07	0.95
5	I do not use electronic resources	1.63	0.86

Table 3 depicts the extent of utilisation of electronic information resources by postgraduate students in Universities of North central Nigeria. Only one had a fairly high mean score which was above the 2.5 mark on a four point Likert scale. It has to do with: I utilise electronic resources twice in a week (\bar{X} =2.57; S.D=0.93) as shown from Table 2, the remaining items had a low mean value below 2.5, these are; I use electronic resource daily (\bar{X} =2.41; S.D=1.00), I use electronic resources once in a week (\bar{X} =2.33; S.D=0.92), I use electronic resources monthly (\bar{X} =2.07; S.D=0.95) and I do not use electronic resources at all (\bar{X} =1.63; S.D=0.86). Thus, it is clear from Table 3 that majority of postgraduate students preferred to use electronic resources twice a week.

Table 4: Reasons for utilizing electronic resources

S/N	Statements	\bar{X}	S.D
1	Electronic resources are easily accessible	3.03	0.86
2	Electronic resources are up to date than printed sources of information	2.89	0.85
3	Electronic resources have no geographical restriction	2.80	0.84
4	Electronic resources are portable	2.58	0.80

Table 4 revealed the reasons for utilising electronic resources by postgraduate students in universities in North-Central Nigeria. Majority of respondents agreed to the following statements as reasons for using electronic resources; electronic resources are easily accessible (\bar{X} =3.03; S.D=0.86); Electronic resources are up to date than printed sources of information (\bar{X} =2.89; S.D=0.85); electronic resources have no geographical restriction (\bar{X} =2.80; S.D=0.84) and electronic resources are portable (\bar{X} =2.58; S.D=0.80). Thus Table 4 revealed that the reason for using electronic resources is that they are easily accessible.

Table 5: Purpose for using electronic resources

S/N	Statements	\bar{X}	S.D
1	I use electronic resources for my assignment	3.40	0.75
2	I use it for preparation for seminar	3.20	0.89
3	I use electronic resources during my thesis and dissertation	3.15	1.23
4	I use for preparing for examination	2.85	1.04

Table 5 shows the purpose of using electronic resources by postgraduate students in universities of North-Central Nigeria. The four statements from Table 4 indicated that postgraduate students use electronic resources for assignments (\bar{X} =3.40; S.D=0.75), preparation for seminars (\bar{X} =3.20; S.D=0.89), during writing of thesis and dissertation (\bar{X} =3.15; S.D=1.23) and for preparation for examination (\bar{X} =2.85; S.D=1.04). Evidently, it is clearly that respondents use electronic resources for their assignments.

Discussion

Table 2 revealed that majority of postgraduate students in universities of North-central Nigeria stated that electronic books and electronic databases are the most available electronic resources in universities of North-Central Nigeria. Out of the type of electronic resources listed, electronic theses and dissertations were least available. Generally, this implies that postgraduate students tend to use electronic books and electronic databases more than other electronic sources. This could be attributed to the fact that some electronic databases have electronic books embedded in them as such the university management will tend to save cost of purchasing electronic books. Moreover, it could be equally attributed to the fact that subscription to individual journals are expensive as such the need to subscribe to electronic databases since most of them contain electronic books and electronic journals. The above findings were in agreement with the findings conducted by Oyedapo and Ojo (2013) who stated that electronic journals, electronic books and electronic databases were readily available at the university library.

In addition, the findings agreed with the report of Chandran (2013) who highlighted the different kinds of electronic resources available to staff and students. Similarly, the findings of this study equally agrees with the opinion of authors like Naqvi (2014), Emwanta and

Nwalo (2010) and Tyagi (2012); as they all enumerated the above information or part of it as constituents of electronic information available to postgraduate students.

Table 3 shows that postgraduate students utilise electronic resources on daily, once a week, twice a week and on a monthly basis. The general low utilisation of electronic resources could be as a result of lack of awareness of the library subscription to electronic resources and also students not having the requisite skills to get the relevant electronic information sources. The finding of this study is in agreement with Singh and Meera (2013) who stated that postgraduate students prefer to use these sources of information twice and thrice a week.

Table 4 shows the reason postgraduate students use electronic resources. The reason for usage of these resources is because its electronic resources are easily accessible, electronic resources are up to date than printed sources of information, electronic resources have no geographical restriction and electronic resources are portable. The general reason of using electronic resources by postgraduate students could be attributed to the provision of good electronic devices like computers and tablets as well as reduction of cost in the purchase of data and bandwidth.

Table 5 shows that postgraduate students use electronic resources for different purposes with majority of them using them for their assignments. This could be attributed to the fact that electronic resources are readily available for use and convenient since they are easily accessible everywhere. The findings of this study is in agreement with Sethi and Panda (2011) who stated that faculty members, research scholars and postgraduate students at the department of Life Science Sambalpur University use electronic resources for different purposes ranging from keeping themselves abreast in their subject area, completion of assignments, research purposes, career development and routine study.

Conclusion

The study found that there was low use of electronic resources by postgraduate students in the universities of North-Central Nigeria. The low use of these electronic resources by students makes it imperative for universities in North-Central Nigeria to provide means or avenues on how to increase utilisation of these sources of information.

Recommendations

Based on the findings of this study, the study recommends the following;

- (i) The university libraries should conduct awareness campaigns on the available subscribed electronic resources in the library through the use of social media platforms like facebook, twitter and blogs.
- (ii) The university management should make electronic resources literacy compulsory for all postgraduate students in order to improve their search strategies.
- (iii) The university library should improve on subscription to different electronic databases so as to cover all subject areas in the university and allocate more funds to infrastructural development in terms of network and internet to make accessibility to electronic resources easy.

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STAFF ATTITUDE AND STAFF ACADEMIC PROFILE AS FACTORS INFLUENCING THE USE OF TWO SPECIAL LIBRARIES IN ABUJA, NIGERIA

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Abstract

The study examined the effect of staff attitude and staff academic profile as factors influencing the use of two special libraries in Abuja. The research aimed to achieve four (4) objectives which were to find out; the frequency of use of the library by the staff members of Economic Community of West African States and Federal Ministry of Youths Development, to find out; factors that enhance the use of library resources in Economic Community of West African States and Federal Ministry of Youths Development, to find out the attitude of staff of Economic Community of West African States and Federal Ministry of Youths Development towards library use and to find out ;if academic profile of staff members of Economic Community of West African States and Federal Ministry of Youths Development influence use of the library. The study employed survey research design. Instrument used for the study was structured questionnaire. The target population were the organisations members of staff. The population for the study consisted of one thousand three hundred and fourteen and two hundred and ninety –eight were sampled. Reeves table (2014) was used to determine the sample size. Data collected was analyzed with the use of simple percentage and frequency count. Two hypotheses were tested at 0.05 level of significance. The findings of the study revealed that there are significant relationships between staff attitude and staff academic profiles with use of special library at an alpha level of 0.05 significance. Staff attitude and staff academic profiles influence the use of special libraries. The study also showed that library users make use of the special library, mainly for reference and research purpose. The study, therefore, recommended that the organisations should provide adequate funding that would assist the library in the acquisition of relevant and current information resources, the library should create awareness on the use of library to Economic Community of West African States and Federal Ministry of Youth Development staff as from the findings, it was discovered that people only use the library for research and reference purposes, since library users are open to new ideas as revealed from the research, the library should acquire more materials that would facilitate professional advancement of staff members of Economic Community of West African States and Federal Ministry of Youth Development. From the findings it was observed during the course of this research that both libraries were greatly understaffed and thus needs to recruit professional librarians whom would improve greatly the quality of services offered and also organize knowledge effectively in these special libraries.

Keywords: *Staff attitude, Staff academic profile, ECOWAS library, Federal Ministry of Youths Development library, Abuja*

Introduction

A Library is a planned collection of books, manuscripts audiovisuals, micro-forms and other records that has been carefully selected and organised to satisfy users' needs Libraries are categorized by two principal characteristics, the user served and the nature of that library collection, with the user being the primary measure of the volume and quality of the collection.

Special Libraries are unique kind of libraries that provide unique information resources on a given subject, to selected group of users; they also deliver qualitative services to these users. Special libraries are established to meet the information needs of their parent organisation, the responsibilities of selecting, acquiring and organizing books, periodicals, documents, newspapers, maps, digital databases, audio-visual materials and other materials that will effectively assist learning, and research in the organisations they serve. Special libraries provide quality resources and services to help the in the achievement of set organisation goals and objectives by their parent institutions. Special libraries exist primarily to help realize the goals and objectives of their parent institution. Some examples of special libraries in Nigeria include the Library of International Institute of Tropical Agriculture (IITA) Ibadan, Nigerian, Lake Chad Research Institute Maiduguri (LCRI) Economic Community of West African States (ECOWAS) Abuja, World Bank of Nigeria, Federal Ministry of Youth Development and many others. Some major objectives of any form of library is to provide an accessible central information resource, designed to support, learning and provoke research in accordance with the objectives of the parent institution they serve. Dissemination of updated information in the concerned field, timely delivery of quality information resources and services to quench the information thirst of users and by creating an enabling and conducive environment for quiet study and open minded debate. The special library works in partnership with the senior management team to develop a learning environment that will support laid down organisational goals and objectives. Murray (2013) defined special libraries as any library that does not support academic activities of public, schools or tertiary categories. Another definition includes any library with a specialised collection, and some definitions also include subject departments within academic and public libraries, which are not separate libraries but operate with some degree of autonomy. Deng (2014) postulated that the lack of consensus among scholars and practitioners can be explained by the variety of types and sizes of special libraries with differing specialized collections, services, and the users they strive to satisfy. Babafemi et.al (2013) defined special libraries as institutions that provide information on the premise of offering relevant information as a means of solving an issue or a need to a unique group of users. An information professional strategically uses the information available to advance the vision of that particular organisation which it serves. The information professional achieves this via the systematic and comprehensive creation, communication and organisation of information resources and services. The information professional harmonizes technology as a necessary tool that can be explored to achieve goals.

Use of special libraries by staff members is essential to the overall development of the organisation as it would provide current information in the various fields or specialty of different staff of the organisation. A medical special library for instance would need current information on new scientific discoveries like information on disease outbreaks, new drugs that have been developed to combat a disease example improvement in Human Immune Virus (HIV) retroviral drugs and best ways on how to prevent the spread of viral diseases to mention but a few that may influence the quality of health services rendered. Information on economic factors that may have an impact on the demand, supply of goods and services, the dollar rates, staff regulations and policies to mention but a few, which will have a great significance on the growth and development of that parent organisation. Aina (2014) opined that artisans for instance need information that would improve their services and their productivity, and attract more customers which would in turn ensure the survival of that business organisation. The underutilisation of such information will also have a negative impact on the quality of goods and services rendered, as the staff members would be under equipped with the necessary information to use and take decisive decisions that will have positive impact on the overall organisational growth and development.

The use of special libraries is however guided by some written down policies for users on how they should behave in the library environment. Users are the central point of all library and information services as they are in constant demand for relevant and up to date information, hence the special library is expected to provide these specialized services to them. Such services include: the selective dissemination of information, current awareness services, information repackaging, document delivery services and others. The services demanded are not static as user needs are dynamic. Library users make use of the library for a variety of reasons some use the library for specific reasons such as professional development, research, personal information needs and for recreational purposes. It is therefore the duty of libraries to ensure that they provide services that would meet the requirement of the users at all times so as to encourage positive attitude towards the use of special libraries. Deng (2014) classified library users into two groups, active users and potential users, Active users actively utilize the library resources while potential library users are people with a unique profile that agrees to the specific requirements in which the organizational system was tailored. These groups of people have been ignored in many user studies. In order to establish an adequate user friendly information facility, it is essential that one has to spot out the potential users and understand their information needs. The conversion from being a potential user to becoming an active user depends on the level of orientation the library offers the community it serves on the available information services. The library system seeks to provide all users with a welcoming, comfortable, and safe environment that promotes free intellectual exploration, research, and learning. Therefore, the use of Special libraries exposes the staff to well-managed and diverse collections of library resources and facilities which are consistent with the circulation and access to databases policy of that particular special library.

Staff attitudes vary from individual to individual, some of which could be based on their upbringing, experience, education, skill, level of exposure, government policies, organizational policies and others. Velnampy (2013) opined that attitudes are the emotions and beliefs that largely determine the perception of employees about their environment, commit themselves to intended actions, and ultimately act accordingly as expected. This idea is further supported by Adesina et.al (2013) who postulated that attitudes are acquired through learning and can be changed through proper orientation. Attitudes once built would help to shape the experience an individual encounter with objects, subjects or persons. It can be said that people's attitudes are dynamic and constantly changing, thus new attitudes are formed and old ones are modified when an individual or group of individuals are exposed to new information and experiences. Abubakar (2013) further elaborates that all attitudes exhibited by people can be categorized into two major headings the explicit which means characters of attitudes that are formed and the implicit which are the behaviours or pattern of attitudes registered in our subconscious minds, and that these attitudes affect people's behaviours or reactions to issues in different ways. However, the attitude of users towards the use of special library plays a significant role in the continuous development of that library.

Academic profiles of users may also influence use of any particular special library which is responsible for the numerous information needs of the various departments found in an organisation. Such departments like administration, finance, advert and marketing, laboratories, communications department, to mention but a few, work together hand in hand to ensure sustainability, growth and development of the organisation. Users of such libraries have different academic backgrounds, this no doubt affects the way and manner in which they need and seek information. In special libraries, there are many users with very high educational qualifications such as PhD and master's degree especially special libraries of research institutes, who often use the library purposefully to advance in knowledge in

their professional disciplines. These groups of professionals are often in charge of the execution and implementation of policies in an organisation. Obochi (2014) observed that despite the high academic profile of special library users, they are not proficient in the use of libraries or information seeking skills. Paul et al (2010) said that library users have different academic backgrounds, while some are very educated, some are not too literate. This group of persons rely mostly on audiovisual resources for their information needs, while some are able bodied, a few could be disabled. Staff with high academic profiles uses the library purposely to enhance their knowledge in specific subjects or disciplines. Researchers who are usually involved in the advancement of knowledge are professionals who create, plan, implement and execute policies.

In a universally competitive environment in which the library operates, libraries face a significant shift amongst the organisational staff in relation to how they go about their search for information and the various medium used to achieve it. The importance and use of special libraries cannot be over emphasised, but still we find out that in most organisations, the staff attitudes towards the use of these libraries are not encouraging as revealed by the observations of one the researchers in the course of industrial training work experience.

In Nigeria, special library users are not numerous compared to the overall population of the organisations concerned as observed by the researchers during supervision in the course of student work industrial experience scheme. It is against this backdrop that the researcher seeks to find out the staff attitude and staff academic profile as factors influencing the use of two special libraries using the special libraries of Economic Community of West African States (ECOWAS) and Federal Ministry of Youths Development both located in Abuja, Nigeria.

Statement of Research Problem

Special libraries are underutilised by the parent organisation which it serves, as the staff of the organisation are not usually keen on library use. This is evidenced on the fact that a small proportion of the staff make use of the special library out of a large population of staff. Obochi (2014) observed that despite the high academic profile of special library users, they are neither proficient in the use of libraries or information seeking skills. It is amazing why staff members would not utilise the library for their academic and professional advancement. It is based on this that the researchers embarked on this study to investigate the roles of staff attitude and staff academic profile as factors influencing the use of two special libraries in Abuja the Federal Capital Territory of Nigeria.

Objectives of the Study

The main objective of this research is to ascertain if staff attitude and academic profile are factors influencing the use of two special libraries in Abuja Nigeria. The specific objectives are to:

- (i) find out the frequency of use of the library by the staff members of Economic Community of West African States and Federal Ministry of Youths Development Abuja;
- (ii) find out factors that enhance the use of library resources in Economic Community of West African States and Federal Ministry of Youths Development. Abuja;
- (iii) Find out the attitude of staff of Economic Community of West African States and Federal Ministry of Youths Development towards library use;
- (iv) Find out if academic profile of staff members of Economic Community of West African States and Federal Ministry of Youths Development influence their

library use.

Research Questions

The following research questions guided the study;

- (i) What is the frequency of use of the library by staff members of Economic Community of West African States and Federal Ministry of Youths Development.?
- (ii) What are the factors responsible for the use of library by staff of Economic Community of West African States and Federal Ministry of Youths Development?
- (iii) What is the attitude of staff of Economic Community of West African States and Federal Ministry of Youths Development towards Library use?
- (iv) Does staff academic profile influence the use of the special libraries in Economic Community of West African States and Federal Ministry of Youths Development?

Hypotheses

The following hypotheses were tested at a 0.05 level of significance

- Ho₁: There is no significant relationship between staff attitude and the use of special libraries in Economic Community of West African States and Federal Ministry of Youths and Culture.
- Ho₂: There is no significant relationship between staff academic profile and special library use Economic Community of West African States and Federal Ministry of Youths and Culture. Abuja Nigeria.

Methodology

Research design

Survey research method was used by the researcher. The choice of the survey as the research design for the research was necessitated by the nature of the study. In survey research, the researcher selects a sample of respondents from a population and administers a standardized questionnaire to them. The questionnaire can be a written document that is completed by the person or group of persons being surveyed. Trochim et al (2016) postulated that the survey was a necessary area of measurement that is most suitable to be applied in social research.

Population of the Study

The population of the study is all the organisations personnel of the two special libraries selected for the study.

Table 1: Population of ECOWAS

S/N	Organisation	Statutory Appointees	Directors	professionals	Local staff	Total
1	ECOWAS	27	51	447	592	1,117

This demographic information was gotten from the Department of Human Resources of Economic Community of West African States, Abuja in November 2016

Table 2: Population of Federal Ministry of Youths and Development

S/N	Organisation	Professional	Administrators	Non-Professional	Total
1	FMYD	66	31	100	197

This information in Table 2 was gotten from the Human Resources Department of the Federal Ministry of Youth Development office, Abuja. In November 2016

The tables 1 and 2 show the staff population in the two special libraries.

Table 3: Total population of the study

Total population	Grand total
ECOWAS	1,117
FMYD	197
Total	1314

In Table 3, it is clear that Economic Community of West African States (ECOWAS), Abuja has a total employee strength of 1,117 as of October 2016. Out of this overall total, there are 27 Statutory Appointees, 51 Directors, 447 Professionals within the P1 - P6 Category and 592 Local Staff.

Federal Ministry of Youths Development Abuja has sixty-six (66) Professional staff, thirty-one (31) Administrative staff, and one hundred (100) non-professionals. The total numbers of staff in the two selected libraries are (1314).

Sampling Technique and Sampling Size

Table 4: Sample size of the study

S/N	ECOWAS	FMYD	Grand total
1	200	98	298

Two sampling techniques were used in this study. It was necessary to select sampling population from each of the organisations. Proportionate sampling technique was used to select total of 98 respondents (47.9%) staff from FMYD out of 197 while 200 (17.9%) staff were selected from 1,117 of ECOWAS making a total of 298 staff. Selecting individually from each of the organisations using proportionate sampling technique was necessary because the organisation with the larger staff gets more population for the sample. Simple random technique was employed to select 98 respondents (49.7%) of the total population in FMYD which was deemed representative, while the same technique was employed to select 17.9% of the total staff in ECOWAS which was also deemed representative of a total of 200. Sampling of the population was required because the total number of population of both organisations were large so the researchers adopted Reeves table (2014) in determining the sample size for the two organisations. The sample size for the two organisations were 298. Sampling fraction used for selecting the sample is 22.7% of the staff of the two organisations, selected by simple random sampling technique and proportionate sampling techniques, based on Reeves table. The researchers considered a sampling population of 298, representing a sampling fraction of 22.7% of 1314 respondent's representative of the total population of the two organisations.

Instrument for Data Collection

The instrument used for the data collection was the questionnaire. The questionnaire was designed under two different subscales known as staff attitude questionnaire (SAQ) and staff academic profile questionnaire (SAPQ). It was designed under two sub-headings. Section A, requested for demographic information which includes, years of working experience, organisation and gender, Section B, was designed to find out the extent of use and factors responsible for use of the organisational libraries.

Validity and Reliability of the Instrument

The research instrument used by the researchers in this study is the questionnaire. The instrument used was validated by experts in library and information science, who examined

and made necessary correction in terms of the structural and grammatical design of the questionnaire.

The Cronbach Alpha method was used to determine the reliability coefficients of the instrument. The values obtained were 0.62 for staff attitude questionnaire (SAQ) while the values obtained for staff academic profile questionnaire (SAPQ) was 0.81.

Method of Data Collection

The method of data collection for the study is through the administration of some copies of questionnaire which were personally distributed by the researchers. The administration of these copies of questionnaires was done solely by the researchers to the staff of the two organizations under study in order to collect the required information.

Data Analysis

Data collected from the administered copies of questionnaire were analysed using simple percentages with the use of tables, frequency counts and percentages which were used to get answers to research questions. The hypotheses were tested using the T- test method.

Data Analysis According Research Questions

Research Question One: What is the frequency of use of the library by staff members of Economic Community of West African States and Federal Ministry of Youth Development

Q1: Do you use the library?

Table 5: Library usage

Statement	Yes	Percent	No	Percent
Do you use the library	222	89%	28	11%

Table 5 reveals that 222(89%) of the respondents use the library while 28 (11%) of the respondents do not use the library.

Q2: How often do you visit the library?

Table 6: Frequency of library use

Statement	Very often		Often		Not often	
	FQ	%	FQ	%	FQ	%
How often do visit the library	134	54%	63	25%	53	21%

Table 6 reveals that 134 (54%) of the respondents use the library very often, 63 (25%) of the respondents use the library often, and 53 (21%) of the respondents do not use the library.

Q3: The library environment is conducive

Table 7: library environment

Statement	SA		A		D		SD	
	FQ	%	FQ	%	FQ	%	FQ	%
Library environment conducive	35	14%	138	55%	35	14%	43	17%

Table 7 reveals that 173 (69%) of the respondent strongly agree and agree that the library environment is conducive while 78 (31%) of the respondent disagree and strongly disagree that library environment is conducive.

Q4: Does the library have comfortable seating arrangements?

Table 8: Seating arrangement

Statement	SA		A		D		SD	
	FQ	%	FQ	%	FQ	%	FQ	%
Does the library have comfortable seating arrangement	44	18%	98	39%	65	26%	44	18%

Table 8 reveals that 142 (57%) of the respondents strongly agree and agree that the library have comfortable seating arrangement while 109 (44%) of the respondents disagree and strongly disagree that the library have comfortable seating arrangement.

Q5. Is the library policy user friendly?

Table 9: Library policy

Statement	SA		A		D		SD	
	FQ	%	FQ	%	FQ	%	FQ	%
Is the library policy user friendly	11	4%	152	61%	54	22%	33	13%

Table 9 Reveals that 163 (65%) of the respondents strongly agreed and agreed that the library policy is user friendly while 87 (36%) of the respondents disagree and strongly disagree that the library policy is users friendly.

Research question 2: what are the factors responsible for the use of library by staff member of Economic Community of West Africa States and Federal Ministry Development Abuja.

Q6. The library has adequate information resources

Table 10: Adequacy of Information resources

Statement	SA		A		D		SD	
	FQ	%	FQ	%	FQ	%	FQ	%
The library has adequate information resources	115	46%	31	12%	63	25%	42	17%

Table 10 Revealed that 146 (58%) of the respondents strongly agree and agree that the library has adequate information resources while 105 (42%) of the respondents disagree and strongly disagree that the library has adequate information resources.

Q7. The information resources are relevant

Table 11: Relevant information resources

Statement	SA		A		D		SD	
	FQ	%	FQ	%	FQ	%	FQ	%
The information resources is relevant	73	29%	83	33%	42	17%	52	21%

Table 11 revealed that 156 (62%) of the respondents strongly agree and agree that the information resources provided by the library is relevant while 94 (38%) of the respondents disagree and strongly disagree that the information resources is relevant.

Q8. The information resources are current

Table 12: Currency of information resources

Statement	SA		A		D		SD	
The information resources is current	FQ	%	FQ	%	FQ	%	FQ	%
	76	30%	44	18%	99	40%	33	13%

Table 12 reveal that 120 (48%%) of the respondents strongly agree and agree that the information resources is current while 132 (53%) of the respondents disagree and strongly disagree that the information resources is current.

Q9. The information resources support the organisation's objectives

Table 13: Suitability of information resources as regards organisation objectives

Statement	SA		A		D		SD	
The information resources support the organisation objectives	FQ	%	FQ	%	FQ	%	FQ	%
	87	35%	77	30%	58	23%	29	12%

Table 13 reveal that 164 (65%) of the respondents strongly agree and agree that the information resources supports the organisations objectives while 87 (35%) of the respondents disagree and strongly disagree that the information resources supports the organisations objectives.

Q10. The resources help professional growth of the staff members.

Table 14: Professional growth of the staff members as result information resources

Statement	SA		A		D		SD	
Does the resources help professional growth of the staff member	FQ	%	FQ	%	FQ	%	FQ	%
	46	18%	125	50%	57	23%	23	9%

Table 14 revealed that 171 (68%) of the respondents strongly agree and agree that the resources help professional growth of the staff member while 80 (32%) of the respondents disagree and strongly disagree that the resources help professional growth of the staff members

Research question 3: what is the attitude of staff members of Economic Community of West Africa State and Federal Ministry of Youth Development?

Q 11: Are you arrogant?

Table 15: Arrogant attitude of staff members

Statement	SA		A		D		SD	
Are you arrogant	FQ	%	FQ	%	FQ	%	FQ	%
	42	17%	10	4%	125	50%	73	29%

Table 15 revealed that 52 (31%) of the respondents strongly agree and agree that they are arrogant while 198 (79%) of the respondents disagree and strongly disagree that they are arrogant.

Q12. Are you nonchalant?

Table 16: Nonchalant attitude of staff member

Statement	SA		A		D		SD	
Are you nonchalant	FQ	%	FQ	%	FQ	%	FQ	%
	10	4%	48	19%	115	46%	77	31%

Table 16 revealed that 10 (4%) of the respondents are nonchalant while 115 (46%) of the respondents disagree and 77 (31%) of the respondents strongly disagree that they are nonchalant

Q13. Are you snobbish?

Table 17: snobbish attitude of staff members

Statement	SA		A		D		SD	
Are you snobbish	FQ	%	FQ	%	FQ	%	FQ	%
	8	3%	83	33%	83	33%	75	30%

Table 17 revealed that 8 (3%) of the respondents strongly agree and agree that they are snobbish while 83 (33%) of the respondents disagree and strongly disagree that they are snobbish.

14. Are you liberal?

Table 18: liberality of staff members

Statement	SA		A		D		SD	
Are you liberal	FQ	%	FQ	%	FQ	%	FQ	%
	68	27%	102	41%	23	9%	57	23%

Table 18 reveals that 68 (27%) of the respondents strongly agree and agree that they are liberal while 102 (41%) of the respondents disagree and strongly disagree that they are liberal.

Q15. Are you open to new ideas?

Table 19: Openness to new ideas

Statement	SA		A		D		SD	
Are open to new ideas	FQ	%	FQ	%	FQ	%	FQ	%
	125	50%	52	21%	52	21%	21	8%

Table 19 revealed that 125 (50%) of the respondents strongly agree and agree that they are open to new ideas while 52 (21%) of the respondents disagree and strongly disagree that they are open to new ideas.

Research question 4: How does the staff academic profile influence the use of libraries in Economic Community of West African State and Federal Ministry of Youths Development.

Q16. Identify your qualifications

Table 20: Qualifications

Statement	Response	Percentage
SSCE	13	5.2%
ND/NCE	13	5.2%
Degree	66	26.4%
Master Degree	66	26.4%
PhD	92	36.8%
Total	250	100%

Table 21 reveals that 13 (5.2%) of the respondents qualification is SSCE, 13(5.2%) of the respondents qualification is ND/NCE, 66 (26.4%) of the respondents qualification is degree, 66 (26.4%) of the respondents qualification is master degree, and 92 (36.8%) of the respondents qualification is PhD.

Q17: Do you use the library as a result of your academic profile?

Table 22: Use of library, based on academic profile

Statement	SA		A		D		SD	
	FQ	%	FQ	%	FQ	%	FQ	%
You use the library as a result of your academic profile	39	16%	116	46%	63	25%	36	14%

Table 22 reveals that 145 (62%) of the respondents strongly agree and agree that they use the library as a result of their academic profile while 99 (39%) of the respondents disagree and strongly disagree that they use the library as a result of their academic profile.

Q.18: What is your purpose of using the library?

Table 23: purpose of using the library

Statement	Response	Percent
Reading of newspaper	35	14
Research purpose	104	42
For leisure	26	10
For reference purpose	86	34

Table 23 reveals that 35 (14%) of the respondents use the library for the purpose of reading newspaper, 104 (42%) of the respondents use the library for research purpose, 26 (10%) of the respondents use the library for leisure purpose, and 86 (34%) of the respondents use the library for reference purpose.

Q19: Using the library helps your professional advancement

Table 24: Professional advancement

Statement	SA		A		D		SD	
	FQ	%	FQ	%	FQ	%	FQ	%
Using the library helps your professional advancement	63	25%	73	29	94	38%	21	8%

Table 24 revealed that 137 (54%) of the respondents strongly agree and agree that the use of library helps their professional advancement while 115 (46%) of the respondents disagree and strongly disagree that the use of library helps their professional advancement.

Q.20: Using the library makes you more knowledgeable

Table 25: knowledge advancement

Statement	SA		A		D		SD	
	FQ	%	FQ	%	FQ	%	FQ	%
Using the library makes you more knowledgeable	95	38%	76	30%	65	26%	22	9%

Table 25 revealed that 95 (38%) and 76 (30%) of the respondents strongly agree and agree that the use of library makes them more knowledgeable while 65 (26%) and 22 (9%) of the respondents disagree and strongly disagree that the use of library makes them more knowledgeable.

Hypotheses Testing

Two hypotheses were tested at 0.05 level of significant, the result of the T-test hypotheses are as follows

Ho₁: There is no significant relationship between staff attitude and use of special library.

Table 26: t- test on relationship between staff attitude and use of special library

	Use of library	Staff attitude
Mean	79.4	63
Variance	724.8	0
Observations	5	5
Pooled Variance	362.4	
Hypothesized Mean Difference	0	
Df	8	
t Stat	1.362134	
P(T<=t) one-tail	0.105134	
t Critical one-tail	1.859548	
P(T<=t) two-tail	0.210268	
t Critical two-tail	2.306004	

Table 26 revealed that there is a significant relationship between staff attitude and use of special library at an alpha level of 0.05 significance. The "t Stat value 1.362134 is < then t Critical two-tail value 2.306004. In the same vein the Probability P(T<=t)two-tail value 0.210268 is greater than 0.05 significant. Thus, the independent null hypothesis is rejected.

HO₂: There is no significant relationship between staff academic profile and use of library.

Table 27: T-test on relationship between staff academic profile and use of library

	Use of Library	Academic Staff Profile
Mean	79.4	60.4
Variance	724.8	33.8
Observations	5	5
Pooled Variance	379.3	
Hypothesized Mean Difference	0	
df	8	
t Stat	1.542525	
P(T<=t) one-tail	0.08076	
t Critical one-tail	1.859548	

P(T<=t) two-tail	0.161519
t Critical two-tail	2.306004

Table 27 Reveals that there is a significant relationship between academic staff profile and use of library at an alpha level of 0.05 the "t Stat value 1.542525 is < the t Critical two-tail value 2.306004. In the same vein the Probability P(T<=t) two-tail value 0.161519 is greater than 0.05 significant. Thus, the independent null hypothesis is rejected.

Discussion of Findings Based on Research Question

Research Question 1: What is the frequency of use of the library by staff members of Economic and Community of West African State and Federal Ministry of Youths Development in Abuja.

Majority of the respondents opted that they use the library as showed in Table 3 with the 222 representing 89% of the total respondents showing the staff members of ECOWAS and FMYD often use the library. The staff member of ECOWAS and FMYD strongly agree and agree that their library has a conducive environment, with the frequency of 173 (69%) and friendly library policy that facilitate their use of the library with a frequency of 163 (65%), however the library seating arrangement is comfortable as 142 (57%) of the total population disagree and strongly disagree to the seating arrangement of the library being comfortable. It is evident that the most of the staff members of the organizations are active users. This is in agreement to the findings of Deng (2014) who classified library users into two groups, active users and potential users, Active users are those who effectively make use of the library and its resources. The response of all the data presented above show that staff of ECOWAS and FMYD use the library, and the library environment is conducive, library policy is user friendly, seating arrangement is not comfortable.

Research Question 2: What are the factors responsible for the use of library by Staff member of Economic Community of West African States and Federal Ministry of Youth Development.

The factors responsible for use of library by ECOWAS and FMYD staff members are adequacy of information resources, relevance of information resources, suitability of information resources as regards organisational objectives and impact on professional growth. The total respondents with the highest frequency strongly agree and agree that the library has adequate information resources with 146 (58%), Relevance of information resources to staff member is 156 (62%), suitability of the information resources to the objective of the organisation with 164 (65%), and enhancement of professional growth of staff members with 171 (68%). This is in accordance to the findings of cholla (2013) stated that the use of library provides conclusive results in advancing the administrative process of the organisation, since they indicate the success and shortcoming in services provided by the library to library users. Though the library holds adequate information resources, majority of the respondents disagree and strongly disagree that information resources provided by the library are current which may hinder improvements in all spheres of the organizations, this is further supported by Liu, (2012) who opined that, among the issues encountered by members of staff, are those related to information provision and library services.

Research question 3: What is the attitude of staff members of Economic Community Of West African State and Federal Ministry of Youth Development.

The following factors were used to measure the attitude of ECOWAS and FMYD staff members. They were arrogance, nonchalance, snobbish attitude, liberal and openness to new ideas. Majority of the respondents while measuring their attitude greatly disagree that they were not arrogant in their attitude with the highest frequency of 198 (79%), 193 (77%) disagree that they are not nonchalant, 158 (63%) disagree that they are snobbish, however majority of the respondents strongly agree and agree that they are liberal in their attitude with the highest frequency of 170 (68%) and 177, while (71%) of the respondents strongly agree that they are open to new ideas. The findings is in contrast with the findings of Gorman(2006) and Clark (2013) who opined, that the low patronage and negative attitude of users towards the library, whether Special, academic or public libraries is as a result of orientation. Thus the staff members of ECOWAS and FMYD have a positive attitude towards the use of their libraries.

Research question 4: How does the staff academic profile influence the use of libraries in Economic Community of West African States and Federal Ministry of Youth Development.

Majority of the respondents are PHD, Master degree, and degree holder with the total frequency of 224 (89%). This indicates that most of the staff members of ECOWAS and FMYD are well educated which in turn facilitate their use of library as majority of the respondents strongly agree and agree that their academic profile influence their use of library with the total frequency of 155 (62%). In the same vein the purpose of their use of the library is mainly for research and reference purposes with the highest frequency of 190 (76%). The use of library by staff members of ECOWAS and FMYD influence the professional advancement of staff members as majority of the respondents strongly agree and agree to this assertion with a total frequency of 136 (54%), and 171 (58%) of the total respondents strongly agree and agree the use of the library increase their knowledge base. The findings of this study are in agreement to the findings of Ocholla (2013) who stated that the use of library provides conclusive results in advancing the administrative process of the organisation, since they indicate the success and shortcoming in services provided by the library to library users.

Discussion of Findings Based on the Tested Hypotheses

Hypothesis 1: There is no significant relationship between staff attitude and use of special library.

Table 26 indicates the T-test table showing the relationship between staff attitude and use of special library. From the result, a statistically significant relationship was found between staff attitude and use of special library in ECOWAS and FMYD ($P(T \leq t) = 0.210268$, $P < 0.05$). Since there is a significant relationship between staff attitude and use of special library, it implies that staff attitude has positive relationship with use of special library. Prior to this, the hypothesis is rejected, which implies that there is a significant relationship between staff attitude and use of special library. This hypothesis has revealed significant positive relationship contrasted to all the questionnaire statement that reveal staff attitude, for instance openness to new ideas, not arrogant, snobbish, nonchalant, in their attitude trigger the staff of ECOWAS and FMYD to use the library judiciously. The findings is in alignment to the findings of Mchombu (2012) and Ocholla(2013) were they pointed out that there is a significant relationship between user attitude and their use of the library.

Hypothesis 2: there is no relationship between academic profile and use of library

Table 27 indicates the T-test table showing the relationship between academic profile and use of library. From the result, a statistically significant relationship was found between academic profile and use of special library in Economic Community of West Africa State and

Federal Ministry of Youth Development ($P(T \leq t) = 0.161519$, $P < 0.05$). Since there is a significant relationship between academic profile and use of library, it implies that academic profile has positive relationship with use of library. Prior to this, the hypothesis is rejected, which implies that there is a significant relationship between academic profile and use of library. This hypothesis has revealed significant positive relationship contrasted to all the questionnaire statement that reveal academic profile, for instance use of library for professional advancement, knowledge acquisition, and research and reference purposes. This is in accordance with the findings of Marcinek (2015) who opined that academic profile of users influences the use of library a great deal, because users academic profile is dynamic, libraries must constantly evaluate their resources and services to cope with increasing user expectation and cope with the modern day advancement.

Conclusion

Based on the findings, special libraries tend to have a large population of users with numerous academic qualifications, as the research findings have shown that the bulk of the organisational staff members are professionals with Degrees, Masters and Doctorates who are in constant demand for current and relevant information in their various specialised field of study. Thus the need for provision of current and relevant diversified information resources is greatly needed as most respondents complained as deduced from their responses from the questionnaire that although the library had relevant resources the bulk of these resources were not current. These findings also showed that staff attitude towards use of special libraries in this organizations are positive and their academic qualifications to a great extent influence their use of the library. It is concluded that current and relevant information resources are relevant tools that when effectively utilized would lead to the overall development of the organisation's staff.

Recommendations

Based on the results of the findings of this study, the following recommendations are offered by the researchers:

- (i) Relevant and current information resources should be made available for the organizational staff in other to foster the economic development of the organizations.
- (ii) The library should create awareness on the use and importance of library to Economic Community of West African States and Federal Ministry of Youth Development staff members, as the research study has shown that people only use the library for research and reference purposes.
- (iii) Since library users are open to new ideas as revealed from the research, the library should acquire more information materials that would facilitate professional advancement of staff members of Economic Community of West African States and Federal Ministry of Youth Development.
- (iv) It was observed during the course of this research that both libraries were greatly understaffed and thus needs to recruit professional librarians whom would improve greatly the quality of services offered and also organize knowledge effectively in these special libraries.

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INFORMATION NEEDS AND SEEKING BEHAVIOUR OF LAWYERS IN NIGER STATE
MINISTRY OF JUSTICE, MINNA

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Abstract

The purpose of this study was to investigate the information needs and seeking behaviour of lawyers in Niger state Ministry of Justice, Minna. In carrying out this study five research questions were posed. The population for this study consisted of all the 91 lawyers in the ministry of Justice Minna, the entire population was used because of the smallness of the population size. Research questions were answered using frequency and percentages. The major findings of the study revealed that lawyers need information for case preparation, service and professional requirements, for improvement of their personal competencies and for research work. The lawyers also require information for current awareness, workshops and seminar presentation. The study further elaborated that the lawyers consult different types of information resources such as bulletin, yearbook, bibliography, encyclopedia, law books and manual. The study further discovered that lawyers seek information for the purpose of improvement on their work, for execution of specific task, for handling of difficult cases and for presentation of law reports. It was therefore recommended that more fund should be allocated for purchase of necessary ICT tools and databases, that lawyers should be trained on the use of ICT and that law libraries should be stocked with current materials.

Introduction

The concept of life is vague without information. Information has enabled a man to perform his routine activities in an efficient way. For decision-making, we need the support of information. Modern society depends on information for all its activities. Every person has the need for information. Without valid and up-to-date information, it is impossible for one to progress in any field of life Abubakar (2010). Understanding of information needs and information-seeking behaviour of various professional groups is essential as it helps in the planning, implementation and operation of information system and services in the given work settings (Abdulsalami, 2013).

Legal information is basic to all, both lawyers and non-lawyers. The law is supposed to be understood and used by every citizen (Hearest, 2009). Lawyers are individuals who have a wide range of responsibilities and duties when it comes to their profession. Their role in society is even more important as they are acting as a voice for others (Exforsys, 2010). In today's world, legal issues spring up almost always on a regular basis. Most probably, one does not have the time to handle all of them. Having a lawyer to take care of one's legal affair is highly of imperative and it is one sure way to get free from unnecessary headaches (Hood, 2006). Lawyers are the protectors of the people. They play a very important role in maintaining order in a society. In addition, a number of positions in government are being held by lawyers. They in no small measure play a great role in ensuring that truth prevail in a society (Buzzle, 2010).

Lawyers are the knowledge workers. They are professionals who have gained knowledge through formal education and through learning on the job (Gottschalk & Karlsen, 2009). The system of legal literacy though it started as far back as 15th century, its scope was narrow,

its appeal limited and its effect minimal. This was brought about by inter alia, the syllabus of the school. It taught the penal code, civil procedure ordinance, constitutional and administrative law, evidence ordinance, Nigerian land law, construction law, law of tort and statutory interpretation.

Lawyers need large variety of information at one time, and needed sources that were structured to enable extensive exploration. These lawyers held that print sources helped the construction process better than computerized sources; as a result, they expressed a desire to have hardcopy material computerized to improve access. Abimbola (2014) observed that the sources used for complex tasks by their user group were paper, computer, and finally people. Complex tasks were defined as those involving considerable thinking and formulation of ideas using legal terms indicating a need for construction of a new approach to be worked out over time. Because this observation was not backed up by any empirical study, the researchers decided to investigate the information need and seeking behavior of lawyers in Niger State Ministry of Justice, Minna.

Objectives of the Study

The general objective of this study was to find out the information needs and seeking behaviour of lawyers in Niger State Ministry of Justice, Minna. Specifically, the study was designed to:

- (i) Identify the information needs of lawyers.
- (ii) Identify the various types of information resources.
- (iii) Identify the sources of information
- (iv) Find the purpose for seeking information.
- (v) Find out constraints to information needs and seeking behavior of lawyers

Research Questions

The following research questions guided the study:

- (i) What are the information needs of lawyers?
- (ii) What are the different types of information resources?
- (iii) What are the sources of obtaining information by the lawyers?
- (iv) What are the purposes of seeking information by lawyers?
- (v) What are the constraints to information needs and seeking behaviour of lawyers?

Literature Review

Many authors have written on information need and gathering behaviour. Information is a valuable resource of today's information society. And acquiring, using and implementing information is a critical activity. This process is known as information seeking process. Information seeking is a broad term, which involves a set of actions that an individual takes to express his information needs, seek, evaluate and select information, and finally uses it to satisfy his information needs. Various factors affect the information seeking behaviours of an individual or a group of individuals, i.e. purpose for information, channels and sources of information and barriers to information. Information seeking is a basic activity of an individual (Tahir, Mohamood & Shafique, 2008).

Wilson (2008) explains that in the 1990's alone the number of publications that was carried out on information seeking behaviour were more than ten thousand. This shows that there are growing number of individual having interest in conducting such research.

Renate (2010) explored the information search process of lawyers. Their findings revealed that these lawyers were frequently involved in complex tasks and to accomplish these complex tasks, they preferred printed texts over computer databases. UNISA (2012) pointed

out that seventy-eight percent of the lawyers agreed that the internet improves their productivity. Eighty-eight per cent of respondents indicated that the internet is useful as a communication tool, whilst 76 percent of the respondents considered the internet to be very important for obtaining information.

The study of Mustaffa and Ahmed (2012) revealed that 57.69% respondents read newspapers daily and 33.33 read occasionally. However, 58.33% of users consulted general magazines, 14.73% read magazines on films, while 16.67% has read magazines related to various competitions. The use of Internet by law students in rural area was very low. There were only sixteen respondents out of one hundred fifty-six, which used the Internet.

The most common information sources are legal publications, whether online or print, and people. The attorneys have many different human resources to call upon, usually beginning with the client, but extending to witnesses, partners, professional groups, subject matter experts, and even people on the street. One attorney sometimes asks people in the elevator or at the grocery store how they feel about an argument she is considering. Less common sources include whistleblowers, court records, arrest records, related lawsuits and list serves. (Renate, 2010). Law is an information - intensive profession, in which there has traditionally been great reliance on external information, calling for a need to identify and access the right sources. The variables of information sources include source credibility - and the dimensions underlying it, such as competence and trustworthiness; homophily - with audience; opinion leadership; and centrality to formal and informal communication networks (Okello - Obura, et al., 2008).

A legal information source that is trusted by its users creates confidence in decision - making in all aspects of the legal activity and will be visited or used, repeatedly. As Utor (2008) observes, an important determinant of the impact that is made by information providers and processors is the trust that users place in the information they provide. Authority is an important determinant of trust. Information users take a number of things into account when assessing the information, they receive. These include the —standing of the information provider; the extent to which it can be seen to be objective; its motive in providing the information, and the likelihood that it will get things right.

Legal sources can be divided into primary and secondary sources. Primary sources are authoritative records of the law made by law making authorities. Secondary sources pertain to the law, but are not authoritative records of the law (i.e. they are not official texts).

Primary materials are the statements of the law itself. Primary materials include acts of parliament, subordinate legislation and reputed decisions of courts and tribunals Renate (2010). The primary frequently consists of two categories of material: legislation (the law made by the legislature or parliament), and the decisions of the Courts of Laws: case or judge made law. There is sometimes a third category of primary material; codes, principles and standards of practice, possibly approved by bodies outside the legislature, parliament or Courts which are recognized as guides to practice. Practicing lawyers need access to statutes, acts and decrees that are legislation passed by the government and are basically arranged according to years accompanied with an index. The most common forms of primary legislation are acts of parliament also known collectively as the statutes. In their draft form, before they have been approved by parliament and received the royal assent, Acts are known as Bills of parliament. There are two types of Acts of Parliament; public general acts containing matters of public policy and which are of general application, and local and personal acts (sometimes referred to as private acts).

Renate (2010) notes that important secondary sources for lawyers include: textbooks, legal journals (which include a variety of both practical and academic articles) and commentary materials (which summarise the law related to particular legal areas). Generally, they include all types of legal literature that are formal records of law such as encyclopedia, digests, cases, textbooks, formats, dictionaries, indexes and bibliographies. According to Renate (2010) law text books are very useful starting point when trying to understand the meaning and effect of major primary sources in an area of law. Reonate (2010) note that some law publishers are starting to provide texts in electronic format. Butterworth has launched books on screen in which selected paper texts have been placed on CD along with electronic versions or related legislation and case law. Users are able to search for information quickly, annotate the text with personal notes and create bookmarks making it possible to return quickly on another occasion to a particular part of the text.

The changing nature of ICT applications in the library setting has brought about different ICT equipment such as network, digital library etc. The digital libraries' collections are either locally stored in digital format or can be remotely accessed through computer networks at various locations. The information contained in such a digital information source can be full-text or bibliographic by nature (Akpoghome and Idiegbeyan-Ose 2010) argued that digital libraries will make the task of legal research more challenging and interesting. He emphasized that the judicial officers (judges), lawyers and or law students in academic work record success in their ability to locate digital sources in the library, especially when retrieved at the time needed. The channels for service delivery in most law libraries in Nigerian universities include electronic databases, internet services, computer system, etc. The application of ICT in Nigerian university libraries has impacted on service delivery in areas such as storage, retrieval and dissemination of information resources.

Research Methodology

Descriptive survey research method was used to carry out this study because the study is interested in describing the information needs and seeking behavior of lawyers. Benard (2012) attested that descriptive research surveys are those studies which aim at collecting data on, and describing in a systematic manner, the characteristics, features or facts about a given population. The target population was the entire 91 lawyers in the Niger state ministry of Justice. For some studies, according to Ifidom (2007), the group of items to which the study relates (i.e the population) may be small enough to warrant the inclusion of all of them in the study. Based on this, no sampling of this population was carried out. The entire population was therefore used because of the smallness of the population size.

The instrument used for data collection in this study was questionnaire. Benard (2012) is of the view that the questionnaire is widely used and is a useful instrument for collecting survey information, providing structured; often numeric data, being able to be administered without the presence of the researchers and often comparatively straight forward to analyze. The instrument before use was face validated by presenting it to three senior colleagues in the field of Library and Information science. These experts were requested to examine the clarity of expression used as well as the appropriateness of language. The researchers administered and collected the questionnaire from the respondents. Thus there was 100% rate of return. The data from the retrieved questionnaire are therefore analyzed using simple statistics like frequencies and percentages

Data Analysis

Table 1: Frequency Distribution of Sex of Respondents

Sex	Frequency	%
Male	55	60
Female	36	40
Total	91	100

Table 1 above showed that 55 (60%) of the lawyers were male while 36 (40%) were female.

Table 2: Frequency Distribution of Working Experience of Respondents

Years of Working Experience	Frequency	%
5-15	18	20
16-25	20	22
26-35	28	31
36-above	25	27
Total	91	100

Table 2 above revealed that lawyers with highest years of working experience were between 26-35 years with 28 (31%) followed by those from 36 years and above with 25 (27%), those that acquired between 16-25 years of working experience were 20(22%) while those with 5-15 years of working experience were 18(20%).

Table 3: Information Needs of Lawyers

Information Needs	Frequency	%
For service and professional requirement	16	17.58
For improving their personal competencies	15	16.48
For current awareness	13	14.28
For research work	15	16.48
For workshops and seminar presentation	14	15.38
For case presentation	18	20
Total	91	100

From the above table, it shows that 18 (20%) of the lawyers seek for information to be utilized for case presentations, 16 (17.58%) of the lawyers affirmed that they need information to be used for service delivery and for professional requirements, 15 (16.48%) of the lawyers each needed information for improvement of their personal competencies and for their research work, 14 (15.38%) of the lawyers need information for workshops and seminar presentation while 13 (14.28%) lawyers confirmed that they need information for current awareness services.

Table 4: Different Types of Information Resources

Types of Information Resources	Frequency	%
Dictionaries	7	8
Encyclopedia	10	11
Law handbook and manual	9	10
Bibliography	8	9
Newspaper	7	8

Newsletter	7	8
Bulletin	9	10
Journals	7	8
Textbooks	10	11
Internet	8	9
Yearbook	9	10
Total	91	100

From table 4, 10 (10%) lawyers each indicated that encyclopedia and textbooks are the major types of information resources they consult. 9(10%) of the lawyers each stated that yearbook, law handbook and manual are the types of information resources they utilize, 8(9%) of the lawyers each indicated that the types of information resources they normally use include: bibliography, internet and yearbook while 7(8%) lawyers elaborated that dictionaries, newspapers and journals are also types of information resources they normally consult.

Table 5: The Sources of Information

Sources of Information	Frequency	%
Law journals	15	16.48
Textbooks	21	23.07
Law reports	14	15.38
Conference proceedings	10	11
Law databases	20	22
Newspapers	11	12.08
Total	91	100

From the above table, it shows that 21(23.07%) of the lawyers indicated that they relied mostly on textbooks as sources of information, 20(22%) of the lawyers got their information from law databases, 15(16.48%) of the lawyers obtained their information from law journals, 14(15.38%) of the lawyers acquire their information from law report, 11(12.08%) of the lawyers obtained their information from newspapers while 10(11%) of the lawyers acquire their information from conference proceedings.

Table 6: The Purpose for Seeking for Information

Purpose for seeking for information	Frequency	%
To improve on work roles/duties	10	11
To be updated on current trends/development in law	11	12.08
To execute a specific work/task	21	23.07
To handle difficult cases	15	16.48
To learn how to use modern ICTs for obtaining of current law information	20	22
To prepare law reports	14	15.38
Total	91	100

As is evident from table 6, a very high proportion of the lawyers 21(23.07%) seek information for the purpose of executing a specific task. 20(22%) of the lawyers seek information on how to use modern ICTs for obtaining current law information, 15(16.48%) seek for information on how to prepare law reports. However, the other two purposes why lawyers seek for information is for them to be updated on current trends/development in law and for improvement on their work roles/duties received significant number of lawyers and percentages of 11(12.08%) and 10(11%).

Table 7: The Constraints to Information Needs and Seeking Behaviour of Lawyers

Constrains to Information	Frequency	%
Lack of current materials on law	7	8
lack of information search skills	8	9
Lack of internet service in remote working areas	9	10
High cost of accessing vital information from existing system	12	13.18
Reliability of credibility of an existing information source	7	8
Lack of awareness of existing information sources	8	9
Delay in accessing desired information from existing system	10	11
Inadequate training of lawyers in the use of information resources	11	12.08
Lack of users' study/survey to ascertain the information needs of lawyers	6	6.09
Law information is tucked away in files marked "secret" or confidential	13	14.28
Total	91	100

Table 7 revealed that the major constraints facing lawyers' access to desired information is that law information is tucked away in files marked "secret" or confidential 13(14.28%), this is followed by the high cost of accessing vital information from existing system 12(13.18%), inadequate training of lawyers in the use of information resources 11(12.08%), delays in accessing information from existing system 10(11%), lack of internet services in remote working areas 9(10%), lack of information search skills and lack of awareness of existing information sources each 8(9%), lack of current materials on law 7(8%) and lack of user study/survey to ascertain the information needs of lawyers 6(6.09%).

Conclusion and Recommendations

From the outcome of the findings, it is established that lawyers in Niger state ministry of justice need information for case preparation, service and professional requirements, for improvement of their personal competencies and for research work. The study also revealed that the lawyers require information for current awareness, workshop and seminar presentations.

The study further elaborated that the lawyers consult different types of information resources such as bulletin, yearbook, bibliography, encyclopedia, law handbook and manual. The study also discovered that other sources of information utilized by the lawyers include law textbooks, databases, law journals and law reports. The study also revealed that lawyers seek information for the purpose of improvement on their work, for execution of specific task, for handling of difficult cases and for the preparation of law reports.

From the findings of the study it was discovered that some constraints deprive the lawyers from obtaining adequate information, such constraints include: Lack of internet services in remote working areas, high cost of accessing vital information from existing system and lack of awareness of existing information sources.

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

- (i) Niger state government should encourage the use of law library through provision of the adequate funds to enable library managers purchase the necessary ICT tools and law databases.
- (ii) Lawyers should be trained on the use of ICT.
- (iii) Law libraries should be stocked with current materials.
- (iv) There is need for automation of law libraries.

- (v) Lawyers should be encouraged to attend conferences and workshops on effective use of information materials.
- (vi) There is need for identification of information needs of lawyers.

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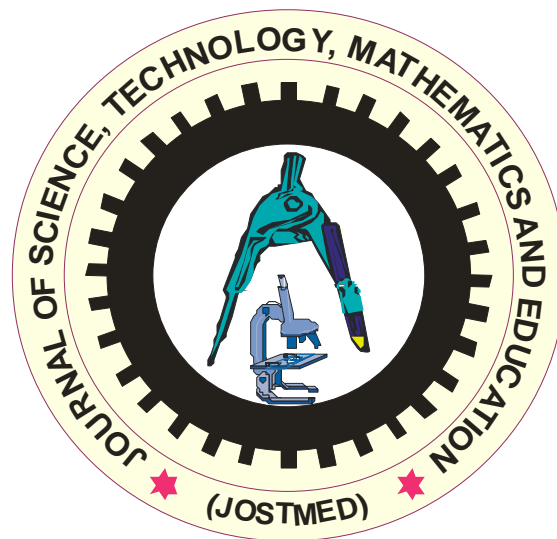
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**ARTICLES AND RESEARCH REPORTS
ON TECHNOLOGY**

EXPERT SYSTEM FOR THE IDENTIFICATION OF CHRONIC KIDNEY DISEASE

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Abstract

Chronic Kidney Diseases (CKDs) are mainly caused by diabetes and high blood pressure. For early detection, certain tests have to be taken such as blood tests, urine tests and imaging tests. The decision about presence or absence of chronic kidney disease depends on the physician's intuition, experience and skill for comparing current indicators with previous one than on knowledge rich data hidden in a database. This measure is a very critical and challenging task. The objective of this paper is to predict patient condition by using an Adaptive Neuro Fuzzy Inference System (ANFIS) pre-processed by grid partitioning. A framework describes methodology for developing and evaluation of classification performances of the proposed system using hybrid learning algorithm least square estimates with Levenberg-Marquardt algorithm that can be used by physicians to accelerate identification process. The proposed method's performance was evaluated with Chronic Kidney Data set obtained from benchmarked datasets of University of California at Irvine's (UCI) machine learning repository. The performance measuring total accuracy, sensitivity and specificity were examined. In comparison, the proposed method achieves superior performance when compared to conventional expert based gradient descent algorithm and some related existing methods. The software used for the implementation is MATLAB R2014a (version 8.3) and executed in PC Intel Pentium IV E7400 processor with 2.80 GHz speed and 2.0 GB of RAM.

Keywords: *Adaptive Neuro Fuzzy Inference System, Chronic Kidney Disease, Grid Partition method, Identification, Levenberg-Marquardt Algorithm.*

Introduction

The rising prevalence of Chronic Kidney Disease (CKD) is emerging as a major global health problem (Wachukwu, Emem-Chioma, Wokoma & Oko-Jaja, 2015). In the developed countries like Nigeria, the cause of the rise of CKD appears not to be due to intrinsic renal disease but to the dramatic rise in systemic diseases that damage the kidney, such as high blood pressure, hypertension and type 2 diabetes. CKD is a prevalent and potentially escalating disease across sub-Saharan Africa with risk factors that include both communicable and non-communicable diseases (Afolabi, Abioye-Kuteyi, Arogundade & Bello, 2009).

The National Kidney Foundation (NKF) estimates that 20 million Americans have chronic kidney disease and at least a further 20 million people have an increased risk (NKF, 2002; Johnson, Levey, Coresh, Levin, Lau & Eknoyan, 2004). In developing countries like Nigeria, Nwankwo, Wudiri and Akinsola (2015) reported an incidence of 45.5% of impaired kidney function among hospitalised hypertensive patients in some part of north east.

In 2012, an estimated 1.5 million deaths were directly caused by diabetes and other 2.2 million deaths were attributed to high blood glucose. The global prevalence of diabetes among adults over the age of 18 years has risen from 4.7% in 1980 to 8.5% in 2014 (World Health Organization, 2016). Two-Thirds of Chronic Kidney Diseases (CKDs) are caused by diabetes and high blood pressure. CKD includes conditions that damages someone's Kidney.

If kidney disease progresses, it may eventually lead to Kidney failure, which requires dialysis or Kidney transplant.

The fuzzy expert systems can be designed to deal with the uncertainty and imprecision of real world problems. Some components of the system are human-like, adaptable and explanations. Two popular and most powerful soft computing techniques of fuzzy logic (Zadeh, 1965) and neural networks (McCulloch & Pitts, 1990), which are complementary to each other rather than competitive for system identification and has the ability to recognize patterns and adapt themselves to cope with changing environment.

Physicians make use of computerised technologies to assist in identification and give suggestion as medical diagnosis is full of uncertainty. Identification of most of the diseases is very expensive as many tests are required for predictions. Neuro fuzzy systems are multilayer connectionist networks that realize the basic elements and functions of traditional fuzzy logic decision systems (Jang, Sun, & Mizutani, 1997).

Nowdays, most of the systems may be considered to be complex in nature. They may be linear or non-linear, predictable or unpredictable. Developing an expert system is of importance in almost all fields, but especially so in Medical disease diagnosis, Transportation, Signal processing and Telecommunication, Engineering (Jang et al., 1997).

Classification techniques are being used in different field of studies to easily identify the type and group to which a particular tuple belongs. Classification is a process that is used to find a model that describes and differentiate data classes or concepts, for the purpose of using the model to predict the target class of each data point (Han, Pei, & Kamber, 2011; Pang-Ning, Steinbach, & Kumar, 2006).

Literature Review

In the literatures about the use of ANFIS approach, the medical sector had a number of related works in which Sugeno fuzzy inference system was applied. (Ziasabounchi & Askerzade, 2014) developed ANFIS model based on hybrid learning algorithm, least squares estimate and gradient descent algorithm. (Ramya & Radha, 2016) developed a method of diagnosis of chronic kidney disease using machine learning algorithm. Back propagation algorithm and Radial Basis Function were used. (Jena & Kamila, 2015) described the distributed data mining classification algorithm for prediction kidney disease based on different algorithms such as Naïve Bayes, Support Vector Machine, Multilayer Perceptron. Settouti, Saidi and Chikh (2012) generates fuzzy classification model for diagnosis of diabetes disease. The combination of fuzzy c-means and neuro-fuzzy rule-based classification technique had been established. The FCM-clustering was adopted to reduce the dimension of the classifier and its training time.

The remaining parts of this paper are organized as follows: in second part materials and methods of this work are presented. This led us to third part in which experiments and results were recorded and analyzed. Fourth part concludes the work.

Materials and Methodology

This section deals with the materials and method used in developing the proposed expert system for the identification of chronic kidney disease.

Descriptive Statistics of the Data Sets

Table 1: Information about input variables for Chronic Kidney Disease Data set

Description of Input variable	Type of Attributes	No. of MF	Min	Max	Std	Mean
Age	Numerical	3	6	90	15.7	53
Blood Pressure	Numerical	3	50	180	13.7	76.1
Blood Glucose Random	Numerical	3	22	490	79.4	145
Hemoglobin	Numerical	3	3.1	17.8	2.9	13
Packed Cell Volume	Numerical	3	9	54	9	39.2

Chronic Kidney Disease Data set is obtained from UCI machine learning repository (Lichman, 2013). This dataset can be used to predict the chronic kidney disease. This data set contains 25 attributes including class attribute with 400 instances. It contains missing values and the characteristics of attributes are real values. The class field refers to the presence of chronic kidney disease of the patient as 1 or absence as 0. In this research work, five input attributes are selected as described in Table 1.

Data Pre-processing

Data pre-processing is a data mining technique that involves transforming raw data into an understandable format. Data pre-processing includes (i) feature selection of the subset of the original or existing features without transformation, and (ii) missing data usually called missing values are nearly universal in statistical practice. Data pre-processing is necessary because real world data are usually incomplete, lacking attribute values, lacking certain attributes of interest, containing only aggregate data or containing discrepancies in codes or names (Roy & Mohapatra, 2013; Scholar, 2015).

Feature Selection

Feature selection is an important step in data pre-processing technique in classification, which is related to dimensionality reduction and can be used to identify the significant attributes (Rajeswari, Vaithyanathan, & Pede, 2013). In the processing medical data, which is often very high dimensional, choosing the optimal subset features is very important, not only to reduce the computational cost or reduce the dimensionality of large datasets, but also to improve the usefulness and gain good classification performance of the model built from the selected data (Ghazavi & Liao, 2008). In this research, feature selection method was applied with the aid of data mining tool, known as Waikato Environment for Knowledge Analysis (WEKA) 3-7-4 software (Frank, Hall, Trigg, Holmes, & Witten, 2004; Sanders, Bridges, McCarthy, Nanduri, & Burgess, 2007; Sharma & Jain, 2013; Yadav, Malik, & Chandel, 2014) based on supervised selecting technique.

Missing Data

Missing data usually called missing values may be due to inconsistency with other record data, data not entered due to misunderstanding or certain data may not be considered important at the time of entry. In this research, listwise deletion was adapted (Allison, 2003; Sauro, 2015; Widaman, 2006). Soley-Bori (2013) highlights the important of listwise deletion as it can be used with any kind of statistical analysis and no special computational methods are required. In other words, listwise deletion is the simplest approach to missing data.

Membership Function

The membership function, often given the designation of μ , as the essence of fuzzy sets. A membership function is a curve that defines how each point in the input space is mapped to a degree of membership usually taken as a real number in the interval [0,1]. The input space is sometimes referred to as the *universe of discourse*, a fancy name for a simple concept. For example, fuzzy set A on the universe of discourse X is defined as $\mu_A : X \rightarrow [0,1]$, where each element of X is mapped to a value between 0 and 1. The selection of membership function type for fuzzy sets is usually determined by experts or chosen depending on its suitability such as simplicity, convenience, speed, and efficiency (Hamdan, 2013; Jang & Sun, 1995). The significant of MFs is to show that each point in the input space is mapped to a membership value (or degree of membership) between 0 and 1. In this research, Gaussian MF was used because of its lower number of parameters. The high the number of MF parameters the more complexity in the fuzzification process.

Proposed Expert System for the Identification of Chronic Kidney Disease

ANFIS was first introduced by (Jang, 1993). The ANFIS is a framework of adaptive techniques to assist learning and adaptation. To illustrate the ANFIS structure, two fuzzy IF-THEN rules, according to a first order Sugeno model, are to be considered for simplicity (Sagir & Saratha, 2017).

According to (Jang et al., 1997), if $f(x, y)$ is a first order polynomial, then the Takagi Sugeno Kang Fuzzy model is given as:

$$\text{IF } x \text{ is } A_i \text{ and } y \text{ is } B_i \text{ THEN } z_i = f(x, y) \quad (1)$$

where A_i and B_i are fuzzy sets in the rule antecedent part, while $z = px + qy + r = f(x, y)$ is a crisp function in the rule consequent part, and p, q & r are the optimal consequent parameters. Usually $f(x, y)$ is a polynomial in the input variables x and y .

Hybrid Learning Algorithm

In designing this new expert system, a hybrid learning technique based on Least squares estimate and the Levenberg-Marquardt algorithm was used. The central difference scheme was applied for computation of the Jacobian Matrix.

Forward Pass

Least squares estimate (LSE) was used at the very beginning to get the initial values of the consequent parameters $S_2 = \{p_i, q_i, r_i\}$ details can be found in (Jang et al., 1997), then at backward pass the Levenberg-Marquardt algorithm (Marquardt, 1963; Yu & Wilamowski, 2011) is to update all parameters. After the consequent parameters S_2 are identified, the network output can be computed and the error measure E_k represents an objective function for k th of the training data can be obtained as:

$$\mathbf{E}_k = (\mathbf{T}_k - \mathbf{O}_k)^2 \quad (2)$$

where \mathbf{T}_k and \mathbf{O}_k represent the target output vector and actual output vector, and N is the number of total points. The overall error measure E of the training data set can be computed using performance measure, root mean square error (RMSE) (Ho, Tsai, Lin, & Chou, 2009) defined as:

$$RMSE = \sqrt{\frac{1}{N} \sum_{i=1}^N \mathbf{E}_k} \quad (3)$$

Backward Pass

In the backward pass, error signals are propagated and antecedent parameters $S_1 = \{\sigma_i, c_i\}$ are to be updated by Levenberg-Marquardt algorithm. The performance index to be optimised is defined by (Madsen, Nielsen, & Tingleff, 2004) and presented as:

$$F(\mathbf{x}) = \frac{1}{2} \mathbf{e}^T \mathbf{e} \quad (4)$$

$F(x)$ is the total error function, $\mathbf{x} = [x_1, x_2, \dots, x_k]$ comprising of all parameter of the network, \mathbf{e} is the error vector comprising the error of all the training samples.

The parameters of unique membership functions of current fuzzy inference system (FIS) is to be obtained, which is a novel approach that allows program to run faster, defined as:

$$\mathbf{v} = I(\mathbf{R}_{ij}) \quad (5)$$

where \mathbf{v} is the index vector that keeps track of the unique MFs, I is the index table of the unique MF used in the rules, \mathbf{R}_{ij} is a matrix of size number of rule by number of input, that identifies the membership functions for the i th rule and j th input.

The Jacobian matrix is to be built column-wise, which contains first order partial derivatives of network error using central difference scheme

$$f'(x_0) = \frac{f_1 - f_{-1}}{2h} + E_{trunc}(f, h), \quad (6)$$

where $f_1 = f(x+h)$. Therefore,

$$\mathbf{J}_{i,j} = \frac{\partial f_i}{\partial x_j} \quad (7)$$

The Hessian matrix is to be approximated, which contains second order partial derivative of network error using the cross product of Jacobian matrix, defined as:

$$\mathbf{H}_{i,j} \approx \frac{\partial^2 f_i}{\partial x_i \partial x_j} \quad (8)$$

To ensure that equation is invertible, another approximation to Hessian matrix is introduced, that is

$$\mathbf{H}^* = \mathbf{J}_k^T \mathbf{J}_k + \Psi \mathbf{I} \quad (9)$$

where Ψ is called combination coefficient or learning parameter, \mathbf{I} is the identity matrix.

With Levenberg-Marquardt method, the increment of the weight in training will be obtained as:

$$\Delta \mathbf{X}_k = (\mathbf{J}_k^T \mathbf{J}_k + \Psi \mathbf{I})^{-1} \mathbf{J}_k^T \mathbf{e} \quad (10)$$

The network parameter needs to be updated as:

$$\mathbf{X}_{k+1} = \mathbf{X}_k - (\mathbf{J}_k^T \mathbf{J}_k + \Psi \mathbf{I})^{-1} \mathbf{J}_k^T \mathbf{e}_k \quad (11)$$

where \mathbf{X} is parameter vector, \mathbf{J}_k is the Jacobian matrix, Ψ is called combination coefficient or learning parameter, \mathbf{I} is the identity matrix and k is the index of iterations.

Recalculate the RMSE using equation (3). And adjust learning parameters, if the current RMSE is less than the previous RMSE, accept and update the consequent parameters.

Initialised $k=0$, $\Psi = \text{user define}$, $\xi = \text{user define}$, $\Psi_{\max} = \text{user define}$ (Max learning rate)

IF $\Psi = \max(\Psi * \xi)$ decrease Ψ , accept. Go back to (3)

ELSE $\Psi = (\Psi * \xi)$, increase Ψ , reject. Go back and recalculate the RMSE

Equation (11) is the update rule of Levenberg-Marquardt algorithm. Depending on the magnitude of Ψ , a method interpolates smoothly between the Gauss-Newton ($\Psi \rightarrow \infty$) and gradient descent ($\Psi \rightarrow 0$). Usually, the Gauss-Newton method is more efficient but

less stable; the gradient descent method is more stable but less efficient. By properly setting the value of Ψ , the Modified Levenberg-Marquardt method can be efficient and well stable (Marquardt, 1963).

Results and Discussion

Based on the data set obtained from UCI machine learning repository, throughout the experiments, two-thirds of examples were selected as training examples and the remaining one-third as test examples. Comparison was made between proposed method and conventional method (ANFIS) based on machine learning process, accuracy, sensitivity and specificity (Colman et al., 1999; Goodall, Colman, Schneider, McLean, & Barker, 2007; Saed, 2015; Waziri, Ozovehe & Isah, 2016) between the models as presented in Table 2.

Table 2: Comparison of results based on performance measures, RMSE for Chronic Kidney Disease Data set

Methodology adopted	Accuracy (%)	Sensitivity (%)	Specificity (%)	RMSE
Proposed method (ANFIS-LM)	89.47	98.03	88.24	0.15994
Conventional method (ANFIS)	85.26	94.21	83.53	0.26448
ANFIS, (Settouti et al. 2012)	83.85	82.05	84.62	-----
BP, (Ramya & Radha, 2016)	80.40	83.00	89.00	-----
RBF, (Ramya & Radha, 2016)	85.30	87.00	92.00	-----

The test performance of the classifier was determined by the computation of sensitivity, specificity, performance error and total classification accuracy, as shown in Table 2 for Chronic Kidney Data set. Based on a comparison of the results, the proposed system produced reasonable results in identifying the possible presence of chronic kidney disease in patients. This assertion is based on the following observation: in Table 2, it is clearly confirmed that none of the cited research work had success rates higher than 85.30% accuracy. The accuracy of the proposed system was obtained as 89.47 % with RMSE 0.15994. The Levenberg-Margquardt algorithm is more effective and it achieved a lower RMSE and thus has higher mapping precision. The dash line (---) indicates that there is no such type of results in the respective existing models.

Conclusion

The objective of this study is to develop a fuzzy system for the identification of chronic kidney disease. This study proposed one major novelty techniques by indexing unique membership functions in a row-wise vector using the vectorisation technique. The computation of Jacobian matrix was built based on standard method, central difference scheme. The applicability of the proposed technique in data classification using one benchmark data set in the area of medical diagnosis was demonstrated. Comparison was made between proposed method, conventional method (gradient descent algorithm) and some of the other related existing methods. The results of the proposed system are better than the results of existing methods and have potential in identifying chronic kidney disease.

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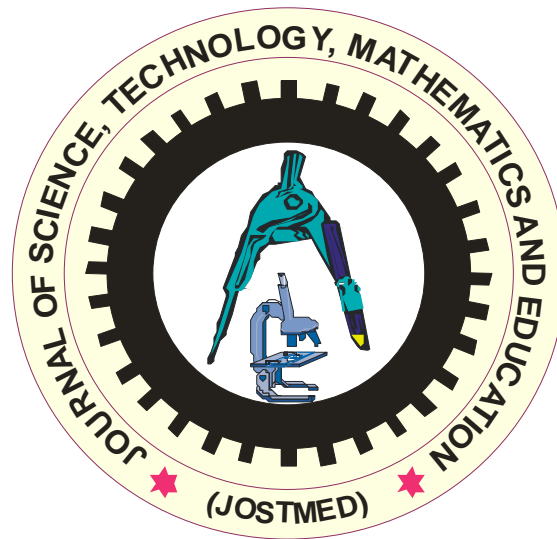
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ARTICLES AND RESEARCH REPORTS ON MATHEMATICS

DEVELOPMENT OF A MATHEMATICAL MODEL FOR UPLAND RICE PRODUCTION
(A CASE STUDY OF NATIONAL CEREAL RESEARCH INSTITUTE BADDEGI,
NIGERIA)

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Abstract

In this paper, mathematical development of two quadratic models was used to obtain minimum, maximum and saddle points of yield response of upland rice production. The results showed that the models were adequate and significant at 5% by using canonical analysis through the methods of least square, R^2 (coefficient of determination) strength, R^2 -adjust, coefficient of variation (CV) and root mean square error (RMSE). The results also indicated that the quadratic effect of irrigation is important during the dry season than nitrogen for optimum yields. It was also established that there was an increase in yield when variance (ANOVA) was used for the data collected from National Cereal Research Institute Baddegi, Niger State. And computation of the data was adequate with R^2 above 60%, R^2 -adjusted above 55% and RMSE was very small.

Keywords: *Upland, Nerica Rice, Quadratic Model, Minimum, Maximum and Saddle Points, Yield Response and Canonical Analysis.*

Introduction

Finley (1972), said response surface methodology examines the relationship between several explained variables. And one or other necessary variables polynomial models are examined through the use of factorial experiment or a fractional factorial design. Response surface methodology is an important way of keeping records to help researchers improve products and services.

Cox (1958), said the application of Mathematics to the production of crops has gained dominance since rice production has become a global issue today through irrigational system and fertilizer application; the application of mathematical modeling becomes imperative. It is known that the mathematical examination of the impact on the objective of production at both rural and urban areas requires appropriate tool such as Mathematical modeling.

Friedman, *etal* (1948) said that mathematical modeling shows the understanding of Mathematics and help in upland rice production to give yield results. Mathematical models are useful examining tools for manipulating and testing theories, accessing quantitative variables, answering constructive questions, accessing sensitivities to changes in parameter values, and examining key parameters from data observed or collected.

Box, *et.al* (1990) said the closer Mathematical believes are to reality of behaviors, the more difficult the Mathematical analysis, hence the need to simplify our fillings without losing track of the situation or fillings at hand. Thus, the choice of using Mathematical modeling approach in this research work cannot be over stated.

Hakimi (2005), said the most appropriate model depends on the precision or generality required, the available data, and the time frame in which results are needed. It is therefore, difficult to express definitively which model is "right", though naturally we are interested in developing models that capture the essential features of a system. Ultimately, we are faced with the usefulness of any model.

This paper is aimed at developing a Mathematical model and analysis of a response surface outlook for upland rice production to meet up with the food consumption of people in Nigeria.

Materials and Methods

In this research work, we intend to know whether there was loss or increase in the yield result of rice production in the direction of application of irrigation system 'I'. Also, we intend to examine the coefficient of determination R^2 , R^2 – adjusted, root mean square error (rmse) and coefficient of variation (CV) to check the model adequacy. So also the model equation formulated will be used to determine the point of maximum, minimum or a saddle point of the rice production.

Quadratic Fit Model

To develop the model equation for the farming system of rice production during the dry season of 2013 and 2014, all possible parameters were taken. We considered the irrigation system 'I', nitrogen fertilizer 'N', and seed varieties of rice 'V' to see the improvement of rice production during the dry season of the years mentioned above.

We also considered the interaction of irrigation system and nitrogen as 'IN', irrigation system and variety of rice as 'IV', nitrogen fertilizer and variety of rice as 'NV'.

The data we used for this research work were collected from NCRI Baddegi, Niger State. The data were based on the field trials during the third quarter of the years mentioned above. The treatments that were applied in the course of experimentation comprised of three (3) irrigation intervals (i.e 7, 14 and 21 days), four (4) fertilizer rates (i.e 30, 60 and 120kg Nha⁻¹) which were randomly allocated to the main plots (i.e the region of interest), while four (4) Nerica rice varieties (i.e 2, 3, 4 and 14) constituted the sub-plots.

The fitting modeled equation for the three factors is;

$$\gamma = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_{11}x_1^2 + b_{22}x_2^2 + b_{33}x_3^2 + b_{12}x_1x_2 + b_{13}x_1x_3 + b_{23}x_2x_3 + \varepsilon \quad (1)$$

Where

γ = yield response

b_i = estimated Parameters ($i = 0,1,2 \text{ and } 3$)

x_1 =I = Irrigation system

x_2 =N = Nitrogen fertilizer applied

x_3 =V = Variety of rice to be produced

ε = random error (i.e constant)

Complete Factorial versus Composite Design

For this research work, we used a complete factorial to produce a model of quadratic surface and it was used instead of a composite design.

A composite design has a 2^k+2k+1 treatment combination, and when we applied it to our research design, we had one factor at three levels i.e $2^1+2(1) + 1 = 5$ and $2^2+2(2) + 1 = 9$ for two factors at four levels. Therefore, the total treatment combinations will be $5 \times 9 = 45$.

On the other hand, for a complete factorial design, we had 3×4^2 factorial which is $3 \times 4 \times 4 = 48$ treatment combinations. Combinational treatment for the composite design is reduced compared to the complete factorial design. Hence, we chose a complete factorial design for the following reasons:

- (i) A full factorial approach will enable equal variance in the estimated effects.
- (ii) It will also allow adequate degrees of freedom for error

Quadratic Surface for More than one Factor

Equation (1) gives a response function of a quadratic fit model for the three factors used in this research work.

$$y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_{11}x_1^2 + b_{22}x_2^2 + b_{33}x_3^2 + b_{12}x_1x_2 + b_{13}x_1x_3 + b_{23}x_2x_3 + \varepsilon$$

Step 1:

The surface is obtained by taking the partial derivatives with respect to x_1, x_2, x_3 and setting them equal to zero, we had

$$\frac{\partial y}{\partial x_1} = b_1 + 2b_{11}x_1 + b_{12}x_2 + b_{13}x_3 = 0 \tag{2}$$

$$\frac{\partial y}{\partial x_2} = b_2 + b_{12}x_1 + 2b_{22}x_2 + b_{23}x_3 = 0 \tag{3}$$

$$\frac{\partial y}{\partial x_3} = b_3 + b_{13}x_1 + b_{23}x_2 + 2b_{33}x_3 = 0 \tag{4}$$

The solutions of these equations give the factorial combinations at which y is a local maximum, minimum or a local stationary value.

Canonical Analysis

We applied canonical analysis to determine whether the stationary point is a maximum, minimum or saddle point. Contour plots may also be used.

Step 2:

Solving equation (2), (3) and (4) to obtain the points of optimum for x_1, x_2 and x_3

$$\left. \begin{aligned} b_1 + 2b_{11}x_1 + b_{12}x_2 + b_{13}x_3 &= 0 \\ b_2 + b_{12}x_1 + 2b_{22}x_2 + b_{23}x_3 &= 0 \\ b_3 + b_{13}x_1 + b_{23}x_2 + 2b_{33}x_3 &= 0 \end{aligned} \right\} \tag{5}$$

$$\begin{aligned} 2b_{11}x_1 + b_{12}x_2 + b_{13}x_3 &= -b_1 \\ b_{12}x_1 + 2b_{22}x_2 + b_{23}x_3 &= -b_2 \\ b_{13}x_1 + b_{23}x_2 + 2b_{33}x_3 &= -b_3 \end{aligned}$$

We write the above system of equation in Matrix form

$$Ax = b \tag{6}$$

$$\begin{pmatrix} 2b_{11} & b_{12} & b_{13} \\ b_{12} & 2b_{22} & b_{23} \\ b_{13} & b_{23} & 2b_{33} \end{pmatrix} \begin{pmatrix} x_1 \\ x_2 \\ x_3 \end{pmatrix} = \begin{pmatrix} -b_1 \\ -b_2 \\ -b_3 \end{pmatrix} \tag{7}$$

By using Cramer's Rule we obtained the value of x_1, x_2 and x_3 as follows:

Let

$$\Delta_1 = \begin{pmatrix} 2b_{11} & b_{12} & b_{13} \\ b_{12} & 2b_{22} & b_{23} \\ b_{13} & b_{23} & 2b_{33} \end{pmatrix} \tag{8}$$

$$\det \Delta_1 = \begin{vmatrix} 2b_{11} & b_{12} & b_{13} \\ b_{12} & 2b_{22} & b_{23} \\ b_{13} & b_{23} & 2b_{33} \end{vmatrix}$$

We solved and arrived

$$x_1 = \frac{(\Delta_1)}{(\Delta_1)} = \frac{\Delta_1}{\det \Delta_1} \tag{9}$$

$$x_1 = \frac{-4 b_1 b_{22} + b_1 b_{23} b_{23} + 2 b_2 b_{12} b_{23} - b_2 b_{12} b_{23} - b_2 b_{13} b_{23} + b_3 b_{13} b_{22}}{8b_{11} b_{12} b_{23} - 2 b_{11} b_{23} b_{23} - 2 b_{12} b_{12} b_{23} + b_{12} b_{12} + b_{12} b_{23} b_{23} + 2 b_{13} b_{12} b_{23}} \tag{10}$$

$$x_2 = \frac{(\Delta_2)}{(\Delta_1)} = \frac{\Delta_2}{\det \Delta_1} \tag{11}$$

$$x_2 = \frac{-4 b_1 b_{11} b_{23} + 2 b_2 b_{11} b_{23} + 2 b_1 b_{12} b_{23} - b_1 b_{23} b_{23} - b_2 b_{13} b_{23} + b_2 b_{13} b_{13}}{8b_{11} b_{12} b_{23} - 2 b_{11} b_{23} b_{23} - 2 b_{12} b_{12} b_{23} + b_{12} b_{12} + b_{12} b_{23} b_{23} + 2 b_{13} b_{12} b_{23}} \tag{12}$$

$$x_3 = \frac{(\Delta_3)}{(\Delta_1)} = \frac{\Delta_3}{\det \Delta_1} \tag{13}$$

$$x_3 = \frac{-4 b_2 b_{11} b_{23} + 2 b_2 b_1 b_{23} + b_3 b_{12} b_{23} - b_2 b_{12} b_{13} - b_1 b_{13} b_{23} + 2 b_1 b_{13} b_{23}}{8b_{11} b_{12} b_{23} - 2 b_{11} b_{23} b_{23} - 2 b_{12} b_{12} b_{23} + b_{12} b_{12} + b_{12} b_{23} b_{23} + 2 b_{13} b_{12} b_{23}} \tag{14}$$

Step 3:

To obtain the optimum response y_m (m is the optimum) we substitute the values of x_1, x_2 and x_3 in to equation (3) below;

$$y = b_0 + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_{11} x_1^2 + b_{22} x_2^2 + b_{33} x_3^2 + b_{12} x_1 b_{13} x_1 x_3 + b_{23} x_2 x_3 + e \tag{15}$$

Step 4:

A determinant matrix is formed to determine the coefficients in the canonical form i.e

$$\begin{pmatrix} 2b_{11} & b_{12} & b_{13} & x_1 \\ b_{12} & 2b_{22} & b_{23} & x_2 \\ b_{13} & b_{23} & 2b_{33} & x_3 \end{pmatrix} \begin{pmatrix} -b_1 \\ x_2 \\ x_3 \end{pmatrix} = \begin{pmatrix} -b_2 \\ -b_3 \end{pmatrix}$$

i.e

$$\begin{pmatrix} 2b_{11} & b_{12} & b_{13} \\ b_{12} & 2b_{22} & b_{23} \\ b_{13} & b_{23} & 2b_{33} \end{pmatrix} \tag{16}$$

We divided R_1, R_2 and R_3 by 2 and we had

$$\begin{pmatrix} \frac{b_{11}}{2} & \frac{b_{12}}{2} & \frac{b_{13}}{2} \\ \frac{b_{12}}{2} & b_{22} & \frac{b_{23}}{2} \\ \frac{b_{13}}{2} & \frac{b_{23}}{2} & b_{33} \end{pmatrix}$$

We had our characteristics equation as:

$$\begin{pmatrix} (b_{11}-\lambda) & \frac{b_{12}}{2} & \frac{b_{13}}{2} \\ \frac{b_{12}}{2} & (b_{22}-\lambda) & \frac{b_{23}}{2} \\ \frac{b_{13}}{2} & \frac{b_{23}}{2} & (b_{33}-\lambda) \end{pmatrix} = 0 \quad (17)$$

Therefore, we solved and arrived at characteristics equation as:

$$-\lambda^3 + (8b_{11} + 8b_{22} + 8b_{33})\lambda^2 - (2b_{12}b_{12} + 2b_{13}b_{13} + 2b_{23}b_{23} - 8b_{11}b_{22} - 8b_{11}b_{33} + 8b_{22}b_{23})\lambda - 6b_{11}b_{22}b_{33} + 2b_{11}b_{23}b_{23} - 2b_{12}b_{13}b_{23} + 2b_{23}b_{13}b_{22} = 0 \quad (18)$$

Step 5

We substituted the values of x_1, x_2 and x_3 by using computer Algebraic symbolic package "Marple software", and subtracted the result from the original equation (i.e equation 3) to have.

$$y - y_m = b_{11}x_1^2 + b_{11}x_1^2 + b_{22}x_2^2 + b_{33}x_3^2 \quad (19)$$

Results

The result obtained in step 5; $y - y_m = b_{11}x_1^2 + b_{22}x_2^2 + b_{33}x_3^2$ can be interpreted as a change in yield from the point of optimum, m to some points $(x_1, x_2$ and $x_3)$.

The following reasons are observed:

If the coefficients b_{11}, b_{12} are all negative, then there is a loss in yield whichever way one goes from m.

- i. If b_{11}, b_{12} are negative and b_{33} is zero, there is still a loss in yield.
- ii. If b_{11} is negative and b_{22} and b_{33} are both zero, there is no unique centre and we have a stationary ridge.
- iii. If b_{11} is negative, b_{22} and b_{33} are both positive and measure an increase in yield along the x_2 or x_3 axis at infinity, then we have a rising ridge.

Fitting Model for 2013 Rice Yield

The model that was fitted for rice yield in 2013 is:

$$y = 26.5 + 0.1x_1 - 0.02x_1^2 + 0.54x_2 - 0.07x_2^2 + 0.000013x_2^3 - 0.098x_1x_2 + 0.0014x_1x_2^2 - 0.000004x_1x_2^3 + 0.004x_1^2x_2 - 0.0001x_1^2x_2^2 + 0.00000021x_1^2x_2^3 \quad (20)$$

where,

y = response estimate for yield

x_1 = irrigation linear effect

x_1^2 = irrigation quadratic effect

x_2 = nitrogen linear effect

x_2^2 = nitrogen quadratic effect

x_2^3 = nitrogen cubic effect

Equation (20) is the response surface polynomial for 2013 rice yield. The ANOVA table below helps us to select the parameters that are significant and needed for the response surface model.

Table 4.1: ANOVA table for 2013 rice yield

SOURCE	Degree of Freedom (df)	Sum of Square (SS)	Mean Squares (MS)	F	P-VALUE
REP	1	17.17	17.17	2.10	0.1508
x_1	2	742.95	317.47	45.52	
x_1	1	741.84	741.84	90.91	0.0001
x_1^2	1	1.11	1.11	0.136	0.7134
x_2	3	198.15	66.05	8.09	
x_2	1	193.40	193.40	23.70	0.0001
x_2^2	1	4.75	4.75	0.58	0.4479
x_2^3	1	0.0002	0.0002	0.000025	0.9957
x_1x_2	6	156.62	26.10	3.198	
x_1x_2	1	38.15	38.15	4.67	0.0335
$x_1x_2^2$	1	24.15	24.15	2.96	0.0892
$x_1x_2^3$	1	2.51	2.51	0.31	0.5805
$x_1^2x_2$	1	85.50	85.50	10.47	0.0017
$x_1^2x_2^2$	1	5.55	5.55	0.68	0.4119
$x_1^2x_2^3$	1	0.76	0.76	0.09	0.7613
ERROR	83	677.66	8.16		
TOTAL	95	1792.54			

Source: (Author, 2016)

From the table above it can be seen that at 5% level of significance the parameters x_1x_2 , $x_1x_2^2$, and $x_1^2x_2$ are significant since their p-values are less than $\alpha = 5\%$ significance level and our final response surface function is;

$$y = 26.5 + 0.25x_1 + 0.54x_2 - 0.098x_1x_2 + 0.004x_1^2x_2 \quad (21)$$

From the ANOVA table above we observed that x_1^2 , x_2^2 and $x_1^2x_2^2$ are not significant at 5% level of significant, therefore, we concluded that effects on rice yield are not significant.

Discussion

Here we will determine whether the stationary point is a point of maximum, minimum or a saddle point.

The fitted model to be used is equation

$$y = 26.5 + 0.25x_1 + 0.54x_2 - 0.098x_1x_2 + 0.004x_1^2x_2 \quad (22)$$

Differentiate equation (4.2) partially w.r.t. x_1 and x_2 and equate to zero to find the optimum point we have;

$$\begin{aligned} \frac{\partial y}{\partial x_1} &= 0.25 - 0.098x_2 + 0.008x_1x_2 \\ 0 &= 0.25 - 0.098x_2 + 0.008x_1x_2 \\ 0.098x_2 - 0.008x_1x_2 &= 0.25 \end{aligned} \quad (23)$$

$$\begin{aligned} 0 &= 0.54 - 0.098x_1 + 0.004x_1^2 \\ 0 &= 0.54 - 0.098x_1 + 0.004x_1^2 \\ 0.098x_1 - 0.004x_1^2 &= 0.54 \end{aligned} \quad (24)$$

Solving simultaneously equation (1.23) and (1.24), we have;

$$x_1 = 16.13 \text{ or } 8.37$$

Substituting $x_1 = 16.13$ and 8.37 into equation (1.24) to obtain values for x_2 , we have;

$x_2 = -8.051$ and 8.054 when $x_1 = 16.13$ and 8.369 respectively; these are the optimum points, that is, $x_1 = 16$, $x_2 = 0$ or $x_1 = 8$, $x_2 = 8$.

We then substitute x_1 and x_2 using $x_1 = 16, x_2 = 0$ and $x_1 = 8, x_2 = 8.05$ in equation (1.20) to obtain the optimum response γ_m as;

$$\gamma_m = 26.5 + 0.25(16) + 0.54(0) - 0.098(16)(0) - (0.004 \times 0)(16)^2$$

$$\gamma_m = 30.5 \text{ is the optimum response for } x_1 = 16 \text{ and } x_2 = 0$$

$$\gamma_m = 26.5 \text{ is the optimum response for } x_1 = 8 \text{ and } x_2 = 8$$

We therefore constructed a determinant matrix as follow to determine the coefficient in the canonical form.

$$\begin{vmatrix} b_{11} - \lambda & (b_{12})/2 \\ \frac{b_{12}}{2} & b_{22} - \lambda \end{vmatrix}$$

Determine the Eigen-values or characteristic roots and equate the determinant to zero, we have;

$$\begin{vmatrix} 0 - \lambda & -0.049 \\ -0.049 & 0 - \lambda \end{vmatrix} = 0$$

Solving the determinant matrix we have;

$$-\lambda(-\lambda) - (-0.049 * -0.049) = 0$$

$$\lambda^2 = 0.002401$$

$$\lambda = \pm 0.049$$

taking the values of λ we have two set of canonical equations as

$$\gamma - 30.5 = 0.049x_1^2 - 0.049x_2^2 \tag{25}$$

$$\gamma - 33.3 = 0.049x_1^2 - 0.049x_2^2 \tag{26}$$

Equation (1.25) is obtained when $x_1 = 16$ and $x_2 = 0$ while, equation (1.26) is obtained when $x_1 = 8$ and $x_2 = 8$. We observed that the contours of both equation (1.25) and equation (1.26) are saddle surfaces because their coefficients b_{11} and b_{22} are positive and negative respectively, which means that there will be a rapid increase in yield if x_1 is increased. This shows that there will be an increase in yield in the direction of x_1 axis from the optimum response M .

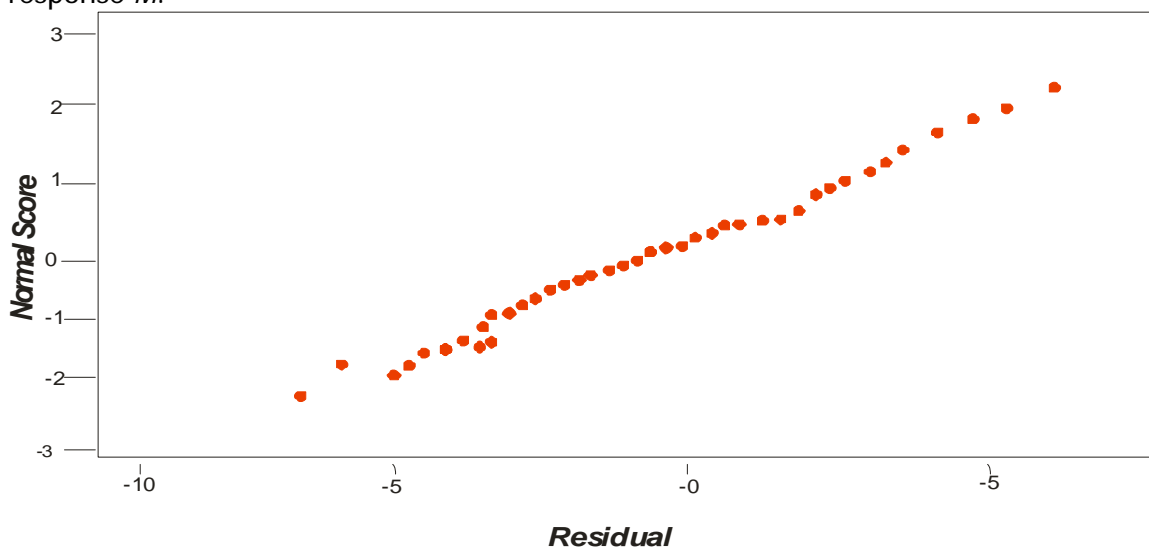


Figure1: Normal probability plot of the residuals for 2013 rice yield

Figure 1 above is the normal probability plot for 2013 rice yield data to check for normality of the data and it appears that the shape confirms the normality of the data.

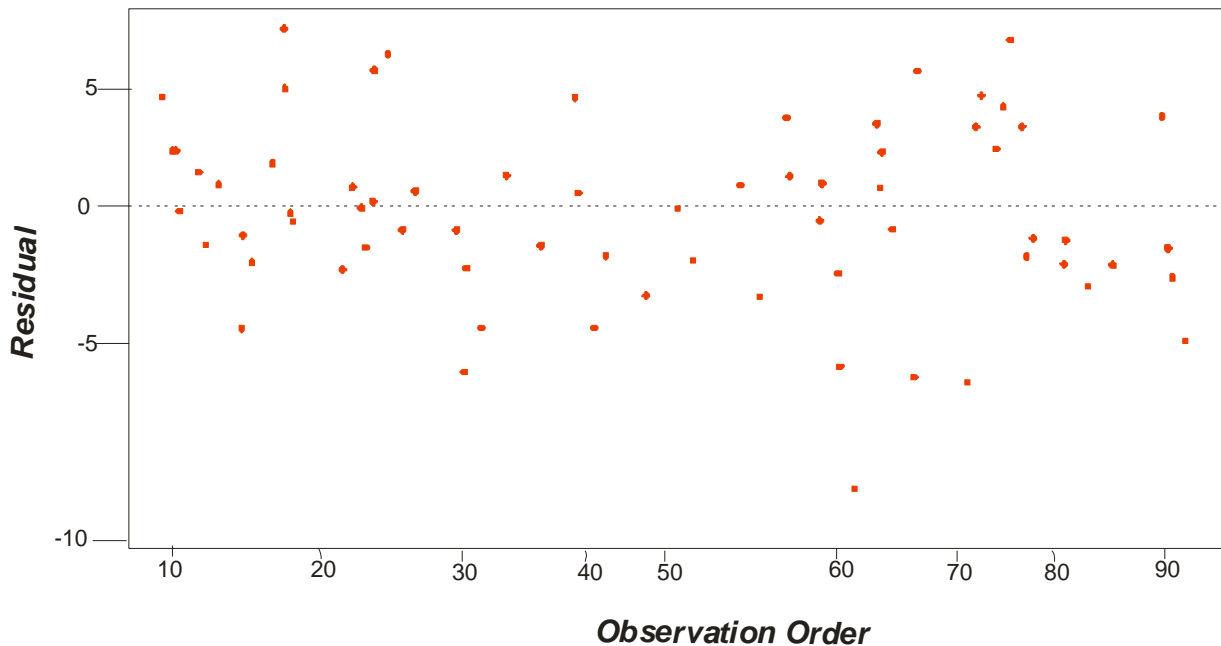


Fig 2: Residuals versus the order of the data for 2013 rice yield

Figure 2 above is a graph showing the residuals versus the order of the data for 2013 rice data it is a confirmatory graph of figure 4.2 (residual versus fitted values).

Conclusion

Basically, a complete factorial experiment where each factor of all the levels are absolutely combined and the model was adequate. We found that the linear and quadratic response surfaces were significant. The model showed that in the optimum response region, there was an increase in yield when irrigation and nitrogen are combined at quadratic and linear effect levels respectively.

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REFINEMENTS OF THE EGYPTIAN FRACTION FINITE DIFFERENCE SCHEME FOR FIRST AND SECOND ORDER INITIAL VALUE PROBLEMS

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Abstract

In this paper, new methods, which are akin to both Runge-Kutta methods and Quasi-Runge-Kutta methods, through a refinement process by Taylor's series expansion of the error term of the existing Egyptian fraction method, were derived. They are less cumbersome than the Hybrid methods while maintaining high accuracy of the numerical results. The methods are used to solve both first and second order differential equations with initial conditions and the results obtained are very favourable because they produced lower absolute error when compared with the existing similar methods.

Keywords: *Refinement, Egyptian fraction, Runge-Kutta, Obrechhoff method*

Introduction

Numerical solution of Ordinary Differential Equation (ODE) is an important technique which has been developed over the years and many different methods are still being proposed and used for finding numerical approximations to the solutions of various types of ODE. However, there are a handful of methods known and used universally which can be categorized mainly as either one-step method or multistep method but the choice of an efficient method is dependent on two main criteria: speed and accuracy.

The Runge-Kutta methods are large class of one-step method algorithms with higher order of accuracy but have always been regarded as expensive because of their multiple function calls in each time step. For example, the four-stage Runge-Kutta method requires four evaluations of the function f per time step and the number of function evaluations is the method's computational Speed.

Another well known method is the block-hybrid method which has very high level of accuracy but it can be rigorous and therefore user's expertise is required.

The use of simple operations to find approximate solution (with high level of accuracy, speed and less complexity) to complex problems cannot be over emphasized in the field of numerical analysis. New methods are constantly being developed and existing methods being refined for the purpose of achieving this goal.

Egyptian Fraction

Ancient Egyptian hieroglyphics revealed to us much about the people of ancient Egypt, including how they did mathematics. The Rhind Mathematical Papyrus, the oldest existing mathematical manuscript, showed that their basic number system was very similar to ours except in one way – their concept of fractions. The ancient Egyptians had a way of writing numbers to at least one million. However, their method of writing fractions was limited. They had no other way of writing fractions, except for a special symbol for $2/3$. This is not to say that the number $5/6$ did not exist in ancient Egypt, they simply had no way of writing it as a single symbol. Instead, they would express it as a sum of unit fractions that is $1/2 + 1/3$ (Izevhizua, 2008; Mohammad, 2012).

They only used fractions of the form $\frac{1}{n}$ so that any other fraction had to be represented as a sum of such unit fractions and, furthermore, all the unit fractions were different. Their notation did not allow them to write $\frac{3}{4}$ or $\frac{6}{7}$ as we would today, instead, they were able to write any fraction as a sum of unit fractions.

For example;

$$\frac{3}{4} = \frac{1}{2} + \frac{1}{4} \tag{2.1}$$

$$\frac{6}{7} = \frac{1}{2} + \frac{1}{3} + \frac{1}{42} \tag{2.2}$$

where all the unit fractions were distinct. The unique fraction that the Egyptians did not represent using unit fractions was $\frac{2}{3}$.

An infinite chain of unit fractions can be constructed using the identity

$$\frac{1}{n} = \frac{1}{n+1} + \frac{1}{n(n+1)} \tag{2.3}$$

Therefore, a fraction written as a sum of distinct unit fractions is called an “Egyptian Fraction”.

It is well-known that every positive rational number can be expressed as a sum of distinct unit fractions (reciprocals of natural numbers). Ancient Egyptians already used such representations of rational numbers, for this reason we call a sum of distinct unit fractions an Egyptian fraction. We note that sometimes unit fractions themselves are called Egyptian fractions.

Any rational number has representations as sum of Egyptian fractions with arbitrarily many terms and with arbitrarily large denominators, although for a given fixed number of terms, there are only finitely many Egyptian fractions.

Thus, *Egyptian fraction* is a term which now refers to any expression of a rational number as a sum of distinct unit fractions (a unit fraction is a reciprocal of a positive integer).

Refinement Process for the Egyptian Fraction Method

We consider the two-step Egyptian fraction scheme (Adeboye and Odio, 2013). given by:

$$y_{n+2} - y_n = \frac{h}{3} (f_{n+2} + 2f_{n+1} + 3f_n) \tag{3.1}$$

For the solution of differential equation of the form $y' = f(x, y)$

The error term is expressed as:

$$y_{n+2} - y_n - \frac{h}{3} (f_{n+2} + 2f_{n+1} + 3f_n) \tag{3.2}$$

For the refinement process (Salisu and Adeboye, 2012)., we expand (3.2) term by term in Taylor’s series and substitute back, the error term is given as:

$$\begin{aligned} & [y_n + 2hy'_n + \frac{2^2h^2}{2!}y''_n + \frac{2^3h^3}{3!}y'''_n + \dots] - [y_n] \\ & - \frac{h}{3} [(y'_n + 2hy''_n + \frac{2^2h^2}{2!}y'''_n + \dots) + 2(y'_n + hy''_n + \frac{h^2}{2!}y'''_n + \dots) + 3y'_n] \end{aligned}$$

Therefore, the error term is $\frac{2h^2}{3}y''_n + O(h^3)$ or $\frac{2h^2}{3}f'_n + O(h^3)$

We can express f'_n as $[\frac{f_{n+1}-f_n}{h}]$

That is;

$$\frac{2h^2}{3} [\frac{f_{n+1}-f_n}{h}] = \frac{2h}{3} [f_{n+1} - f_n] + O(h^3) \tag{3.3}$$

Adding equation (3.3) to (3.1), we have

$$y_{n+2} - y_n = \frac{h}{3}(f_{n+2} + 2f_{n+1} + 3f_n) + \frac{2h}{3}[f_{n+1} - f_n] + O(h^3) \quad (3.4)$$

Thus, we have a new scheme 1 below:

Scheme 1

$$y_{n+2} = y_n + \frac{h}{3}[f_{n+2} + 4f_{n+1} + f_n]$$

Also, we can express f'_n as $\left[\frac{f_{n+\frac{1}{4}} - f_n}{\frac{h}{4}}\right]$.

That is;

$$\frac{2h^2}{3} \left[\frac{f_{n+\frac{1}{4}} - f_n}{\frac{h}{4}}\right] = \frac{2h}{3}[f_{n+\frac{1}{4}} - f_n] + O(h^3) \quad (3.5)$$

Adding equation (3.5) to equation (3.1), we have

$$y_{n+2} - y_n = \frac{h}{3}(f_{n+2} + 2f_{n+1} + 3f_n) + \frac{2h}{3}[f_{n+\frac{1}{4}} - f_n] + O(h^3) \quad (3.6)$$

Thus, we have another new scheme 2 below:

Scheme 2

$$y_{n+2} = y_n + \frac{h}{3}[f_{n+2} + 2f_{n+1} + 8f_{n+\frac{1}{4}} - 5f_n]$$

Again, we can express f'_n as $\left[\frac{f_{n+\frac{1}{2}} - f_{n+\frac{1}{4}}}{\frac{h}{2}}\right]$.

That is:

$$\frac{2h^2}{3} \left[\frac{f_{n+\frac{1}{2}} - f_{n+\frac{1}{4}}}{\frac{h}{2}}\right] = \frac{4h}{3}[f_{n+\frac{1}{2}} - f_{n+\frac{1}{4}}] + O(h^3) \quad (3.7)$$

Adding equation (3.7) to equation (3.1), we have

$$y_{n+2} - y_n = \frac{h}{3}(f_{n+2} + 2f_{n+1} + 3f_n) + \frac{4h}{3}[f_{n+\frac{1}{2}} - f_{n+\frac{1}{4}}] + O(h^3) \quad (3.8)$$

Thus, we have the third scheme 3 below:

Scheme 3

$$y_{n+2} = y_n + \frac{h}{3}[f_{n+2} + 6f_{n+1} - 4f_{n+\frac{1}{2}} + 3f_n]$$

Convergence of the Methods

The necessary and sufficient conditions for a linear multistep method to be convergent are that it must be consistent and is zero-stable. [Lambert, 1974].

For Consistency:

Theorem 1: The linear multistep method

$$\sum_{j=0}^k \alpha_j y_{n+j} = h \sum_{j=0}^k \beta_j f_{n+j}$$

is said to be consistent with the differential equation:

$$y'(x) = f(x, y), \quad y(x_0) = y_0$$

if and only if

- i. $\rho(1) = 0$
- ii. $\rho'(1) - \sigma(1) = 0$

where $\rho(\xi)$ and $\sigma(\xi)$ are the first and second characteristic polynomial

Zero-stability

Theorem 2: A linear multi-step method is zero-stable for any ordinary differential equation, if the roots of the first characteristic polynomial $\rho(\xi)$ lies inside the closed unit disc, with any root which lie on the unit circle being simple.

Scheme 1

$$y_{n+2} - y_n = + \frac{h}{3} [f_{n+2} + 4f_{n+1} + f_n]$$

For consistency:

$$\begin{aligned} \rho(\xi) &= \sum_{j=0}^2 \alpha_j \xi^j = \xi^2 - 1 \\ \rho(1) &= \sum_{j=0}^2 \alpha_j = 1 - 1 = 0 \\ \rho'(1) &= \sum_{j=0}^2 j\alpha_j = 2(1) - 0(1) = 2 \\ \sigma(\xi) &= \sum_{j=0}^2 \beta_j \xi^j \\ \sigma(1) &= \sum_{j=0}^2 \beta_j = \frac{1}{3} + \frac{4}{3} - \frac{1}{3} = \frac{6}{3} = 2 \end{aligned}$$

For zero-stability:

$$\rho(\xi) = \xi^2 - 1 = (\xi + 1)(\xi - 1) = 0$$

$\xi = -1$ and 1 which satisfy the zero stability condition.

Since Scheme 1 is both consistent and zero-stable, it is therefore convergent

Scheme 2

$$y_{n+2} - y_n = \frac{h}{8} (f_{n+2} + 2f_{n+1} + 8f_{n+\frac{1}{2}} - 5f_n)$$

For consistency:

$$\begin{aligned} \rho(\xi) &= \sum_{j=0}^2 \alpha_j \xi^j = \xi^2 - 1 \\ \rho(1) &= \sum_{j=0}^2 \alpha_j = 1 - 1 = 0 \\ \rho'(1) &= \sum_{j=0}^2 j\alpha_j = 2(1) - 0(1) = 2 \\ \sigma(\xi) &= \sum_{j=0}^2 \beta_j \xi^j \\ \sigma(1) &= \sum_{j=0}^2 \beta_j = \frac{1}{8} + \frac{2}{8} + \frac{8}{8} - \frac{5}{8} = \frac{6}{8} = 2 \end{aligned}$$

For zero-stability:

$$\rho(\xi) = \xi^2 - 1 = (\xi + 1)(\xi - 1) = 0$$

$\xi = -1$ and 1 which satisfy the zero stability condition.

Since Scheme 2 is both consistent and zero-stable, it is therefore convergent

Scheme 3

$$y_{n+2} - y_n = \frac{h}{8} (f_{n+2} + 6f_{n+1} - 4f_{n+\frac{1}{2}} + 3f_n)$$

For consistency:

$$\rho(\xi) = \sum_{j=0}^2 \alpha_j \xi^j = \xi^2 - 1$$

$$\rho(1) = \sum_{j=0}^2 \alpha_j = 1 - 1 = 0$$

$$\rho'(1) = \sum_{j=0}^2 j\alpha_j = 2(1) - 0(1) = 2$$

$$\sigma(\xi) = \sum_{j=0}^2 \beta_j \xi^j$$

$$\sigma(1) = \sum_{j=0}^2 \beta_j = \frac{1}{2} + \frac{6}{2} - \frac{4}{2} + \frac{3}{2} = \frac{6}{2} = 2$$

For zero-stability:

$$\rho(\xi) = \xi^2 - 1 = (\xi + 1)(\xi - 1) = 0$$

$\xi = -1$ and 1 which satisfy the zero stability condition.

Since Scheme 3 is both consistent and zero-stable, it is therefore convergent

Numerical Experiments

Problem 1: $y' = f(x, y) = x + y; \quad y(x_0) = 1$

$$y_E(x) = 2e^x - x - 1$$

Problem 2: $y'' = y - 4x, \quad y(x_0) = 0, \quad y'(x_0) = 1$

$$y_E(x) = \frac{3}{2}(e^{-x} - e^x) + 4x$$

Table 5.1: Solution to problem 1. Showing the absolute error of the new schemes compared with existing Adeboye's scheme at $h = 0.1$

x	Exact solution	Adeboye's Scheme	Scheme1	Scheme 2	Scheme 3
0.1	1.110341836	0.000000000	1.8448×10^{-4}	1.8448×10^{-4}	1.8448×10^{-4}
0.2	1.242805516	1.4506207×10^{-2}	2.57×10^{-5}	7.00252×10^{-4}	7.51654×10^{-4}
0.3	1.399717616	1.7034217×10^{-2}	2.01027×10^{-4}	6.250560×10^{-4}	1.127244×10^{-3}
0.4	1.583649396	3.5399604×10^{-2}	5.551×10^{-5}	1.715606×10^{-3}	1.851145×10^{-3}
0.5	1.797442542	4.1406275×10^{-2}	2.22891×10^{-4}	1.796314×10^{-3}	2.46557×10^{-3}
0.6	2.044237600	6.477844×10^{-2}	9.0462×10^5	3.151589×10^{-3}	3.412893×10^{-3}
0.7	2.327505414	7.5501445×10^{-2}	2.51162×10^{-4}	3.449316×10^{-3}	4.331022×10^{-3}
0.8	2.651081856	1.0535194×10^{-1}	1.31807×10^{-4}	5.145035×10^{-3}	5.585484×10^{-3}
0.9	3.019206222	1.2239277×10^{-1}	2.87175×10^{-4}	5.739458×10^{-3}	6.893552×10^{-3}
1.0	3.436563656	1.6060829×10^{-1}	1.81074×10^{-4}	7.872758×10^{-3}	8.561106×10^{-3}

Table 5.2: Solution to problem 1, showing the absolute error of the new schemes compared with existing Adeboye's scheme at $h = 0.01$

x	Exact solution	Adeboye's Scheme	Scheme1	Scheme 2	Scheme 3
0.1	1.110341836	7.28223×10^{-4}	1.2×10^{-8}	3.63×10^{-6}	3.665×10^{-6}
0.2	1.242805516	1.609525×10^{-3}	2.8×10^{-8}	8.024×10^{-6}	8.082×10^{-6}
0.3	1.399717616	2.668028×10^{-3}	4.1×10^{-8}	1.3301×10^{-5}	1.3402×10^{-5}
0.4	1.583649396	3.931226×10^{-3}	5.6×10^{-8}	1.9599×10^{-5}	1.9755×10^{-5}
0.5	1.797442542	5.430442×10^{-3}	7.3×10^{-8}	2.7078×10^{-5}	2.73×10^{-5}
0.6	2.044237600	7.201318×10^{-3}	9.3×10^{-8}	3.5913×10^{-5}	3.6216×10^{-5}
0.7	2.327505414	9.284377×10^{-3}	1.12×10^{-7}	4.6309×10^{-5}	4.6705×10^{-5}
0.8	2.651081856	1.1725658×10^{-2}	1.36×10^{-7}	5.8496×10^{-5}	5.9003×10^{-5}
0.9	3.019206222	1.4577425×10^{-2}	1.57×10^{-7}	7.2737×10^{-5}	7.3371×10^{-5}
1.0	3.436563656	1.7898966×10^{-2}	1.84×10^{-7}	8.9324×10^{-5}	9.0119×10^{-5}

Table 5.3: Solution of problem 2, showing absolute error of scheme 1 compared with Obrechhoff's method at $h = 0.1$

x	Exact solution	Obrechhoff's scheme	Scheme 1
0.1	0.0994997499	5.0083×10^{-6}	5.0041×10^{-6}
0.2	0.1959919924	1.00667×10^{-5}	1.00333×10^{-5}
0.3	0.2864391197	1.52258×10^{-5}	1.51124×10^{-5}
0.4	0.3677430226	2.05374×10^{-5}	2.02666×10^{-5}
0.5	0.4367140835	2.60545×10^{-5}	2.55207×10^{-5}
0.6	0.4900392536	3.18323×10^{-5}	3.08998×10^{-5}
0.7	0.5242488945	3.79287×10^{-5}	3.64286×10^{-5}
0.8	0.5356820534	4.44048×10^{-5}	4.21321×10^{-5}
0.9	0.5204498229	5.13252×10^{-5}	4.80349×10^{-5}
1.0	0.4743964191	5.87594×10^{-5}	5.41614×10^{-5}

Discussion of Results and Conclusion

In the first problem, the Egyptian fraction scheme together with its refined schemes are applied to first order Initial Valued Problem (IVP) and it can be seen in Table 5.1 and Table 5.2 that though the Egyptian fraction scheme is accurate, the new refined schemes are more accurate because they produce lower absolute error when compared with the original scheme and particularly, scheme 1 is with the lowest error.

Scheme 1 which is with the lowest error is further applied to second order IVP as demonstrated in Table 5.3 and Table 5.4 and is compared with the well-known Obrechhoff's method for second order problem. It can be seen that both methods have very high level of accuracy but scheme 1 is still with lower absolute error.

Table 5.4: Solution of problem 2, showing absolute error of scheme 1 compared with Obrechhoff's method at $h = 0.01$

x	Exact solution	Obrechhoff's scheme	Scheme 1
0.1	0.0994997499	5.002501×10^{-4}	5.002501×10^{-4}
0.2	0.1959919924	1.0055055×10^{-3}	1.0029993×10^{-3}
0.3	0.2864391197	1.5208219×10^{-3}	1.5107467×10^{-3}
0.4	0.3677430226	2.0513554×10^{-3}	2.0259909×10^{-3}
0.5	0.4367140835	2.6024144×10^{-3}	2.5512292×10^{-3}
0.6	0.4900392536	3.1795128×10^{-3}	3.0889558×10^{-3}
0.7	0.5242488945	3.7884248×10^{-3}	3.6416594×10^{-3}
0.8	0.5356820534	4.4352432×10^{-3}	4.2118188×10^{-3}
0.9	0.5204498229	5.1264399×10^{-3}	4.8018973×10^{-3}
1.0	0.4743964191	5.8689308×10^{-3}	5.4143349×10^{-3}

In conclusion, it can be observed that these are some Quasi-Runge-Kutta methods which are much simpler to obtain and implement than the Runge-Kutta methods and are also less cumbersome than the block methods but with comparable accuracy.

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SEASONAL AND CYCLIC FORECASTING FOR HYDRO- ELECTRIC POWER GENERATING STATION

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Abstract

Effective forecasting is an inevitable tool for managers and administrators who are always occupied with strategic decision making under uncertainty. Electric power load forecasting is a vital process in the planning of electricity industry and the operation of electric power systems. It facilitates electric power-generation strategies, by pre-informing power providers to take appropriate mitigating actions to minimize risks and manage demand. In this paper, monthly electric power load data collected from hydro-electric power generating station, Kainji, for seven years (2008 – 2014), were analyzed and used to forecast future power values. The patterns of distribution of previous power generation data over a period of time (i.e., in form of Time series), which include trend, seasonality, cyclicity, and randomness, were identified using Decomposition approach. The choice of an appropriate forecasting method was then determined, future values were projected and power forecasts were made for the next few periods. For reasons of clarity and uniformity, points of significance and mathematical procedures were discussed and shown in the context of a business case typical of most industries.

Keywords: Forecasting, Hydro-electric power generation, Time series, Decomposition approach

Introduction

Electricity as a product has very different characteristics compared to a material product. For instance, electricity energy cannot be stored as it should be generated as soon as it is demanded. One of the objectives of any commercial electric power company is to provide end users (market demands) with safe and stable electricity. Therefore, Electric Power Load Forecasting is a vital process in the planning of electricity industry and the operation of electric power systems. Accurate forecasts lead to substantial savings in operating and maintenance costs, increased reliability of power supply and delivery system, and correct decisions for future development. Electricity demand is assessed by accumulating the consumption periodically; it is almost considered for hourly, daily, weekly, monthly, and yearly periods.

The literature on electricity load forecasting extends as far back as the mid-1960s (Heinemann et al. 1966; Hahn et al. 2009). While Kalman filter and state space methods dominated the literature early on, artificial and computational intelligence methods and econometric techniques have largely dominated literature that is more recent. Time series techniques have been extensively used in load forecasting for decades and are among the oldest methods applied in forecasting (Hahn et al., 2009; Bunn & Farmer, 1985a, 1985b; Weron, 2006; Kyriakides & Polycarpou, 2007). Two overarching classes of time series regression models have emerged to address the time-scale issues in different ways. Amaral et al. (2008) contend the two broad classes of conceptual models include: (1) single-equation models and (2) multi-equation (vector) models. This distinction between single-equation models and multi-equation (vector) models is important because we utilize the

multi-equation approach in our estimation. Irrespective of which approach is adopted, when constructing a time series model there are four components that must be taken into consideration: trend, cyclical, seasonality, and a random white noise error. Consequently, the time series literature can be envisioned in terms of how it has addressed each of these components. In general, accounting for both cyclical and seasonality has been extensively covered in the literature whereas trend, while addressed, is typically not the focus of the analysis.

Within the literature, load data has occasionally been found nonstationary. Some, Darbellay and Slama (2000) for example, first difference the data to account for nonstationarity. Other studies, however, find that fitting a deterministic trend is more appropriate. Soares and Medeiros are highly critical of authors' tendency to first difference without first testing for a unit root or even considering a linear trend (2008). Soares and Medeiros (2008) point out that when the trend is in fact deterministic, taking the first difference will introduce a non-invertible moving average component, which in turn, will cause serious estimation problems. Upon examining hourly load data for Rio de Janeiro, Soares and Medeiros (2008) find that the data display a positive linear trend.

Time series is a collection of data points on a quantitative characteristic of a phenomenon that are typically measured at successive and uniformly-spaced time intervals (Shumway & Stoffer, 2006). It plays an important role in many forecasting approaches, and has been extensively used in subject areas as climate science, finance and econometrics. Thus, time series provides statistical setting for describing seemingly random fluctuating data and projecting the data series into the future.

Forecasting is about predicting future events based on a foreknowledge acquired through a systematic process or intuition (Armstrong, 2001), (Lewis & McGrath, 2011). The birth of forecasting as a science, however, is associated with weather forecasting and, is credited to Francis Beaufort, who developed the popularly known scale for measuring wind force (the Beaufort scale) and Robert Fitzroy, who developed the Fitzroy barometer for measuring atmospheric pressure (Ireneous and Daniel, 2013). Forecasting has advanced over time and has increased in sophistication in many specialized areas, including the fields of health, economics and commerce, sports, environment (including meteorology), technology and politics. The prediction of future events is a critical input into many types of planning and decision making processes. Many decision-making applications depend on a forecast of some quantity. For example, when a company plans its ordering or production schedule for a product it sells to the public, it must forecast the customer demand for this product so that it can stock appropriate quantities-neither too much nor too little.

Almost all managerial decisions are based on forecasts. Every decision becomes operational at some point in the future, so it should be based on forecasts of future conditions. Forecasts are needed continually throughout an organization, and as time moves on, their impact on actual performance is measured; original forecasts are updated; and decisions are modified, and so on. Forecasts of the future values of critical quality characteristics of a production process can help determine when important controllable variables in the process should be changed, or if the process should be shut down and overhauled.

The selection and implementation of the proper forecast methodology has always been an important planning and control issue for most profit maximizing firms and agencies. Often, the financial well-being of the entire business operation may rely on the accuracy of the forecast since such information will likely be used to make interrelated budgetary and operative decisions in areas of personnel management, purchasing, marketing, advertising

and capital financing. Any significant over-or-under power forecast error may cause the industry to be overly burdened with excess inventory carrying costs or else create lost sales revenue through unanticipated item shortages.

The classical decomposition of time series is often based on the four components: trend, cyclic, seasonal, and random components, where:

- (i) *Trend* is the long-term variation in a time series that is not influenced by irregular effects or seasonally related components in the data. In this case, *Growth or Decay Trends* are tendencies for power to increase or decrease fairly steadily over time. For instance, in power-generation data, an overall record of a progressively increasing generation over a specified period would show an increasing trend, irrespective of any random or systematic fluctuations.
- (ii) *Cyclicity* results when the pattern of a time series data (e.g. containing the incidence of power events/situations) is influenced by some periodic (long-term/short-term) fluctuations that are associated with other characteristics (Ireneous & Daniel, 2013). *Cyclic Oscillations* are general up-and-down power changes due to changes in the overall economic environment (not caused by seasonal effects).
- (iii) *Seasonality* is also a cyclic phenomenon, but is related to annual events, and is described as the predictable and repetitive positions of data points around the trend line within a year. *Seasonalities* are regular power fluctuations which are repeated from year to year with about the same timing and level of intensity; these effects are usually associated with calendar or climatic changes.
- (iv) *Randomness or Irregularity* is also a common feature of time series data, and refers to unexpected distortions of existing or anticipated trends. *Irregularities* are any power fluctuations not classified as one of the above.

A reliable power forecast is important for quality and sufficient electric-power service delivery. Thus in this work, monthly electric power load data collected from hydro-electric power generating station, Kainji, for seven years (2008 – 2014), were analyzed and used to forecast future power values by means of decomposition approach.

Methodology

The data for the analysis are on total monthly generated electric power for seven years (2008 – 2014) collected from Kainji hydro-electric power generating station, Niger state. The data are therefore secondary in nature. There are many forecasting methods available, these methods can generally be divided into three groups:

- (i) Judgmental methods
- (ii) Extrapolation (or Time Series) methods, and
- (iii) Econometric (or causal) methods.

The extrapolation methods are quantitative methods that use past data of a time series variable to forecast future values of the variable. In this work, trend-based regression approach, which is one of the extrapolation methods of forecasting, is adopted. This approach searches for patterns in the historical series and then extrapolates these patterns into the future. The prediction is based on an inferred study of past general electric-power data behavior over time. This forecasting methodology is generally applicable to situations where useful future data estimates are desired. For reasons of clarity and uniformity, points of significance and mathematical procedures are discussed and shown in the context of a business case typical of most industries.

Mathematically, a time series is defined by the values Y_1, Y_2, \dots of a variable Y at times t_1, t_2, \dots . Thus,

$$Y = F(t) \tag{2.1}$$

Forecasting as one of the main goals of time series analysis is an uncertain process and because of the uncertainty, the accuracy of a forecast is as important as the outcome predicted by the forecast. The information provided by the forecasting process can be used in many ways. An important concern in forecasting is the problem of evaluating the nature of the forecast error by using the appropriate statistical tests. We define the best forecast as the one which yields the forecast error with the minimum variance. The multiplicative modeling approach is used in this work to examine the four types of components that influence the power data. That is

$$Y_t = S_t \times T_t \times C_t \times I \tag{2.2}$$

Where $S, T, C,$ and I denotes, respectively, seasonal, trend, cyclical and irregular components.

It is always a good idea to have a feel for the nature of the data before building a model, time series plots can reveal ‘patterns’ such as random, trends, level shifts, periods or cycles, unusual observations, or a combination of patterns. Excel 2013 and MINITAB 17 were used as aids for analysis.

Results and Discussion

A time series plot of the generated electric power data for the period under review is given in figure 3.1 below.

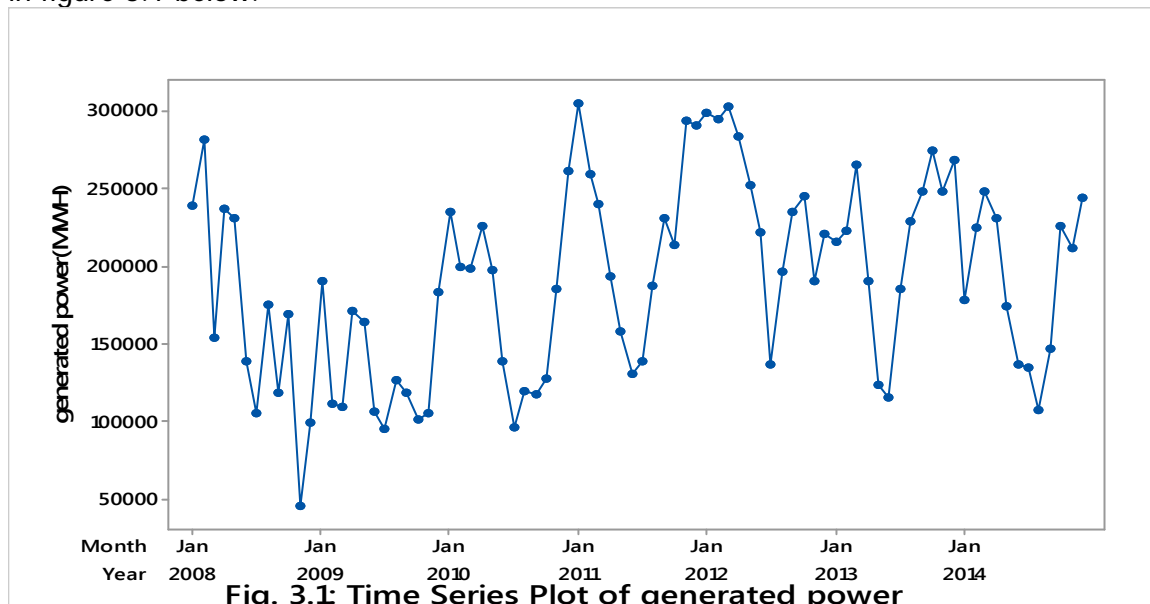


Fig. 3.1: Time Series Plot of generated power

From figure 3.1 above, we observe the following characteristics of the data:

- (i) Within each year, there seems to be an initial period of electric power decline followed in turn by an interval of growth with some minor up-and-down power movement.

- (ii) The series exhibits a number of peaks, but they do not appear to be equally spaced. This output suggests that if the series has a periodic component, it also has fluctuations that are not periodic--the typical case for real-time series.
- (iii) Aside from the small-scale fluctuations, the significant peaks appear to be separated by more than a few months. The series exhibits typical highs during the first and last quarter of every year which is an indication that the time series probably has an annual periodicity.
- (iv) The seasonal variations appear to grow with the upward series trend, suggesting that the seasonal variations may be proportional to the level of the series, which implies a multiplicative model rather than an additive model.

Decomposing the Power Data

From the above analysis of the figure 3.1 time series plot, it is easily seen that the series consists of all the four components – *Seasonal, Trend, Cyclical* and *Irregular* components - so it is very important that these components be separated out of the 'raw' power levels. To be able to make a proper power forecast, we must know to what extent each of these components is present in the power data. Hence to understand and measure these components, the forecast procedure involves initially removing the component effects from the power data (decomposition). After the effects are measured, making a power forecast involves putting back the components on new power estimates (recomposition).

Deseasonalizing the Power Data

We now take the first step in time series decomposition by removing the recurrent and periodic variations (seasonal effects) from the power data over a short time frames (months in this case). To measure seasonal effects, seasonal index for every period, which represent the extent of seasonal influence for that period, is estimated. Seasonal indexes are estimated by

$$S_i = D_i / D \tag{3.1}$$

where:

S_i = the seasonal index for i^{th} period,

D_i = the average values of i^{th} period,

D = grand average,

i = the i^{th} seasonal period of the cycle.

The estimated seasonal indexes for the generated power data are given in Table 3.1 below, with the monthly seasonal indexes in the last row of the table.

Table 3.1: Seasonal indexes

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2008	238559	281151	154037	237202	230473	138702	105380	175326	118839	169765	46433	99481
2009	190058	112081	109623	171026	164583	106477	95726	127170	119200	102065	106065	183215
2010	235095	200034	198736	225929	197781	138869	96317	119969	117511	127565	185220	261296
2011	304358	258973	240065	193389	158631	131406	139042	187617	231329	213893	293193	290899
2012	298679	294858	302202	283719	251910	221446	137205	197076	235181	244778	190844	220876
2013	215582	222935	264874	190416	124203	115838	185517	229133	247886	274342	248103	268097
2014	178086	224865	248107	231246	174846	137481	135438	108225	146876	226036	211417	244090
IIN DEX	1.24	1.192	1.134	1.145	0.973	0.739	0.668	0.855	0.909	1.015	0.957	1.171

From these indexes, we may quantitatively measure how far above or below a given month stands in comparison to the expected power period (the expected power is represented by a seasonal index of 100%, or 1).

The original power data are then deseasonalized by dividing every observation in the data by the seasonal index of the corresponding month. These are given in table 3.2 below.

The strength of the seasonal effect on the original power data can be seen in column (3) of table 3.2 below, which depicts a plus(+) or minus(-) sign for each period's seasonal index which is above or below expected power level (seasonal index of 100%), respectively. This column clearly shows an annual seasonal pattern of above average power in the beginning periods followed by an interim time interval of below average power, and ending each year alternating 'above' average power with 'below' average power. These uninterrupted 'highs' and 'lows' in the seasonal index set represent a very strong seasonal effect in the data. We then remove this influence so as to further study the power data for other component effects. The remaining columns of table 3.2 give the original and the corresponding deseasonalized power.

Table 3.2: The deseasonalized power

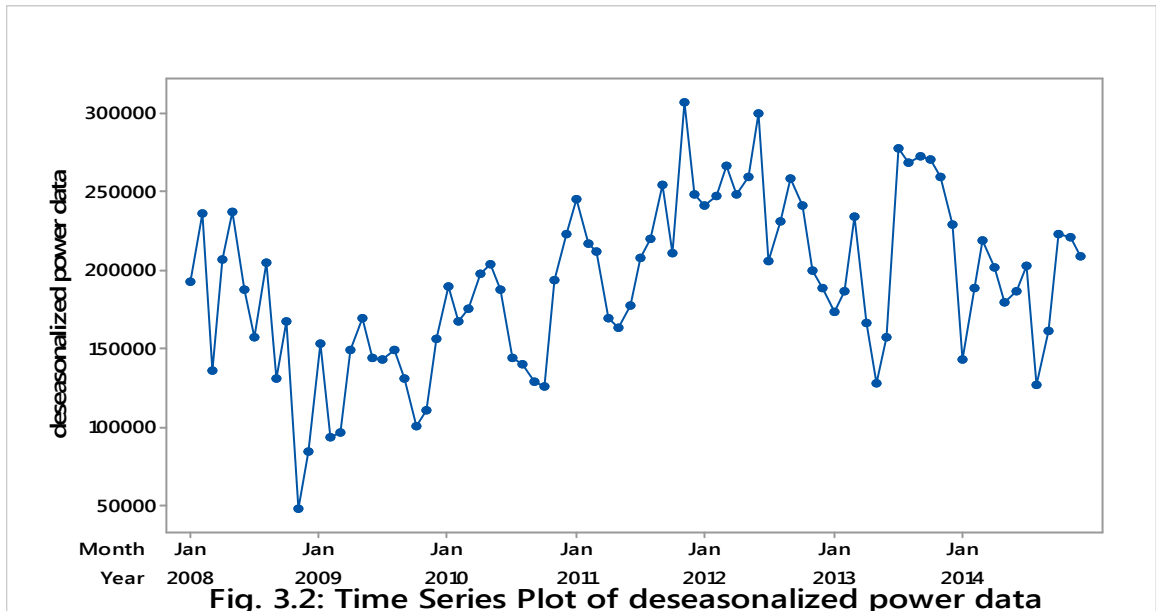
Month	Seasonal index (%)	Seasonal strength	Original 2008 gen. power	2008 deseasonalized power	Original 2009 gen. power	2009 deseasonalized power	Original 2010 gen. power	2010 deseasonalized power
J	124	+	238559	192386.29	190058	153272.581	235095	189592.742
F	119.2	+	281151	235864.933	112081	94027.6846	200034	167813.758
M	113.4	+	154037	135835.1	109623	96669.31	198736	175252.2
A	114.5	+	237202	207163.3	171026	149367.7	225929	197317.9
M	97.3	-	230473	236868.4	164583	169150.1	197781	203269.3
J	73.9	-	138702	187688.8	106477	144082.5	138869	187914.7
J	66.8	-	105380	157754.5	95726	143302.4	96317	144187.1
A	85.5	-	175326	205059.6	127170	148736.8	119969	140314.6
S	90.9	-	118839	130736	119200	131133.1	117511	129275
O	101.5	+	169765	167256.2	102065	100556.7	127565	125679.8
N	95.7	-	46433	48519.33	106065	110830.7	185220	193542.3
D	117.1	+	99481	84953.89	183215	156460.3	261296	223139.2

Table 3.2: cont'd

month	Seasonal index(%)	Original 2011 gen. power	2011 deseasonalized power	Original 2012 gen. power	2012 deseasonalized power	Original 2013 gen. power	2013 deseasonalized power	Original 2014 gen. power	2014 deseasonalized power
J	124	304358	245450	298679	240870.2	215582	173856.452	178086	143617.742
F	119.2	258973	217259.228	294858	247364.1	222935	187026.007	224865	188645.134
M	113.4	240065	211697.5	302202	266492.1	264874	233575	248107	218789.2
A	114.5	193389	168898.7	283719	247789.5	190416	166302.2	231246	201961.6
M	97.3	158631	163032.9	251910	258900.3	124203	127649.5	174846	179697.8
J	73.9	131406	177816	221446	299656.3	115838	156749.7	137481	186036.5
J	66.8	139042	208146.7	137205	205396.7	185517	277720.1	135438	202751.5
A	85.5	187617	219435.1	197076	230498.2	229133	267991.8	108225	126578.9
S	90.9	231329	254487.3	235181	258725	247886	272701.9	146876	161579.8

O	101.5	213893	210732	244778	241160.6	274342	270287.7	226036	222695.6
N	95.7	293193	306366.8	190844	199419	248103	259250.8	211417	220916.4
D	117.1	290899	248419.3	220876	188621.7	268097	228947.1	244090	208445.8

The time series plot of the deseasonalized power data from this table are given in figure 3.2 below.



We can see from this figure that the deseasonalized power data do not oscillate as widely as the original power levels. Any remaining up-and-down movement must therefore be due to trend, cyclic, or irregular effects. Next we fit a trend equation to the original power data using the least squares method. This is given as

$$\hat{Y} = \hat{a} + \hat{b}t \tag{3.2}$$

Where \hat{Y} = predicted power level (due to the trend effect) occurring in period t ,
 \hat{a} = intercept of the trend line equation,
 \hat{b} = power growth rate per period (i.e., slope of the trend line equation).

By the least squares method, the fitted trend line equation for the original power data was

$$Y_t = 157222 + 800t \tag{3.3}$$

This line represents the overall linear trend of the power growth over time. Next we estimate the trend components and then remove the trend effect from the deseasonalized data. Figure 3.3 below shows a plot of the original, deseasonalized and estimated trend data.

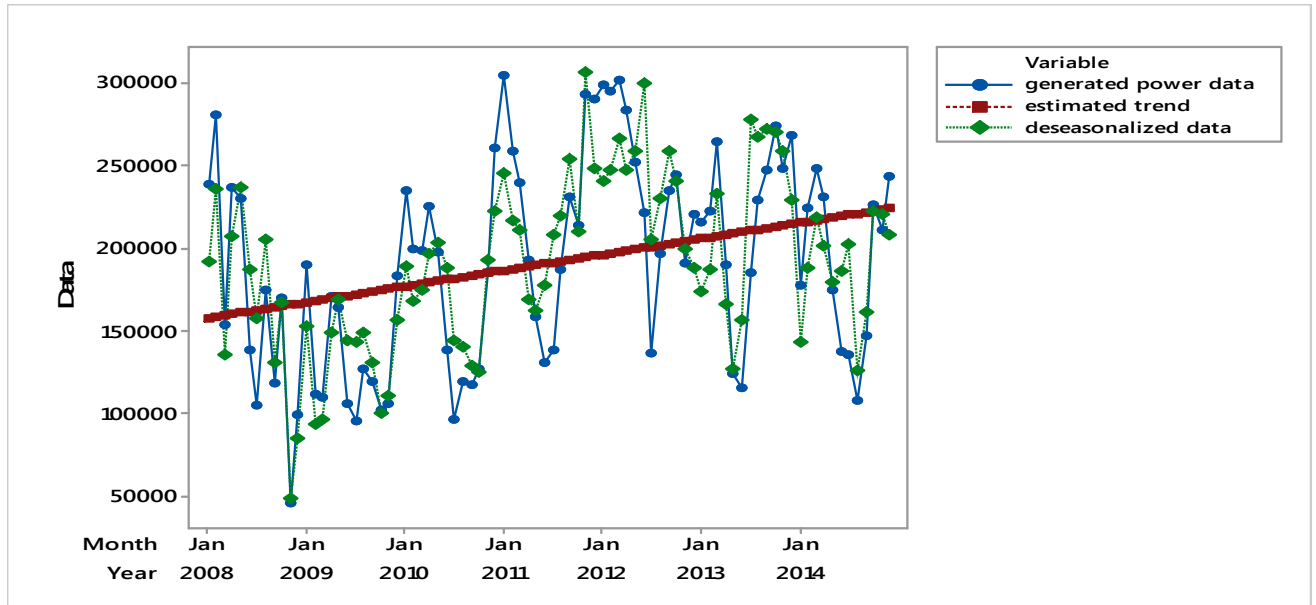


Figure 3.3: Time series plot of the original, deseasonalized and estimated (trend) power

From figure 3.3, the effect of the seasonal component is apparent in the sense that the deseasonalized data oscillates less widely than the original data. The fitted trend line shows the direction of movement of the two series.

Measuring the Cyclic Effects

We now calculate a series of cyclic indexes to enable us measure the effect of the general hydro-generating cycle on the power levels. We do this by expressing each value in the deseasonalized power data as a percentage of the calculated trend for the same date using the above trend line equation. The resulting time series has no trend, but oscillates around a central value of 100. These are given in Table 3.3 below.

Table 3.3: Cyclical Index

month	2008 deseasonalized power	Predicted (trend) power	Cyclic index (%)	2009 deseasonalized power	Predicted (trend) power	Cyclic index(%)	2010 deseasonalized power	Predicted (trend) power	Cyclic index(%)
J	192386.3	153364	125.4	153272.6	164759	93	189592.7	176153	107.6
F	235864.9	154314	152.8	94027.68	165708	56.7	167813.8	177103	94.8
M	135835.1	155263	87.5	96669.31	166658	58	175252.2	178052	98.4
A	207163.3	156213	132.6	149367.7	167607	89.1	197317.9	179002	110.2
M	236868.4	157162	150.7	169150.1	168557	100.4	203269.3	179951	112.9
J	187688.8	158112	118.7	144082.5	169506	85	187914.7	180901	103.9
J	157754.5	159061	99.2	143302.4	170456	84.1	144187.1	181850	79.3
A	205059.6	160011	128.2	148736.8	171405	86.8	140314.6	182800	76.8
S	130736	160960	81.2	131133.1	172355	76.1	129275	183749	70.4
O	167256.2	161910	103.3	100556.7	173304	58	125679.8	184699	68
N	48519.33	162859	29.8	110830.7	174254	63.6	193542.3	185648	104.3
D	84953.89	163809	51.9	156460.3	175204	89.3	223139.2	186598	119.6

Table 3.3: Cont'd

month	2011 deseasonalized power	Predicted (trend) power	Cyclic index (%)	2012 deseasonalized power	Predicted (trend) power	Cyclic index (%)	2013 deseasonalized power	Predicted (trend) power	Cyclic index (%)
J	245450	187548	130.9	240870.2	198942	121.1	173856.5	210337	82.7
F	217259.2	188497	115.3	247364.1	199892	123.7	187026	211286	88.5
M	211697.5	189447	111.7	266492.1	200841	132.7	233575	212236	110.1
A	168898.7	190396	88.7	247789.5	201791	122.8	166302.2	213185	78
M	163032.9	191346	85.2	258900.3	202740	127.7	127649.5	214135	59.6
J	177816	192295	92.5	299656.3	203690	147.1	156749.7	215084	72.9
J	208146.7	193245	107.7	205396.7	204639	100.4	277720.1	216034	128.6
A	219435.1	194194	112.9	230498.2	205589	112.1	267991.8	216983	123.5
S	254487.3	195144	130.4	258725	206538	125.3	272701.9	217933	125.1
O	210732	196093	107.5	241160.6	207488	116.2	270287.7	218882	123.5
N	306366.8	197043	155.5	199419	208438	95.7	259250.8	219832	117.9
D	248419.3	197993	125.5	188621.7	209387	90.1	228947.1	220782	103.7

Table 3.3: Cont'd

Month	2014 deseasonalized power	Predicted (trend) power	Cyclic index (%)
J	143617.7	221731	64.8
F	188645.1	222681	84.7
M	218789.2	223630	97.8
A	201961.6	224580	89.9
M	179697.8	225529	79.7
J	186036.5	226479	82.1
J	202751.5	227428	89.1
A	126578.9	228378	55.4
S	161579.8	229327	70.5
O	222695.6	230277	96.7
N	220916.4	231227	95.5
D	208445.8	232176	89.8

We now assign each period a plus(+) or minus(-) to signify whether the period is thought to be above or below the cyclic average (cyclic index = 100%) for power. Such assignments for all periods in all given years are shown in table 3.4 below using the above full cyclic index calculations.

Table 3.4: Plus/Minus Indicators of Cyclic Index Set

M	2008	2009	2010	2011	2012	2013	2014
J	+	-	+	+	+	-	-
F	+	-	-	+	+	-	-
M	-	-	-	+	+	+	-
A	+	-	+	-	+	-	-
M	+	+	+	-	+	-	-
J	+	-	+	-	+	-	-
J	-	-	-	+	+	+	-
A	+	-	-	+	+	+	-
S	-	-	-	+	+	+	-
O	+	-	-	+	+	+	-
N	-	-	+	+	-	+	-
D	-	-	+	+	-	+	-

On examination of the plus/minus assignments from the above table, beginning and ending periods for the first three years are difficult to discern. However, from June to December 2009 is a time interval of economic downturn, and from July 2011 to October 2012, there is clearly an economic upturn shown by the long string of plus signs during this time interval.

The whole 2014 is another economic downturn. To gain further insight, we plot the cyclic indexes for all periods in Figure 2.4.

However, as the business cycle is usually longer than the seasonal cycle, cyclic analysis is not expected to be as accurate as a seasonal analysis. Due to the tremendous complexity of general economic factors on long term behavior, a general approximation of the cyclic factor is the more realistic aim. Thus, in reference to the Figure 3.4 plot of cyclic indexes, the specific sharp upturns and downturns are not so much the primary interest as the general tendency of the cyclic effect to gradually move in either direction.

To study the general cyclic movement rather than precise cyclic changes (which may falsely indicate more accuracy than is present under this situation), we 'smooth' out the cyclic plot by replacing each index calculation with a centered 7-month moving average. This is to dampen out the many up-and-down minor actions of the cycle index plot so that only the major changes remain. These moving averages are given in Table 3.5 below. Plots of the cyclic index set and smoothed index set are shown in Figure 3.4.

Table 3.5: 7-month index smoothing of the cyclic indexes

M	2008	2009	2010	2011	2012	2013	2014
J	*	68.8	88.8	105.5	126.9	94.5	97.5
F	*	68.4	96.7	107.9	129.9	86.4	91.2
M	*	76.3	102.4	106.3	128.7	83.1	86.1
A	123.8	80.9	101	104.6	125.1	88.6	84
M	124.2	80	96.6	102	123.8	94.5	82.7
J	114	82.8	93.1	104.2	124	99.7	80.6
J	116.3	82.8	88.8	103.6	121.7	101.6	80.5
A	101.6	79.1	87.9	113.1	117.8	107.3	81.3
S	87.5	77.6	88.9	118.9	112.4	113.6	82.7
O	83.8	80.8	92.8	122.9	103.2	112.4	*
N	77.7	82.3	97.9	125.2	101.5	106.2	*
D	67.7	83.9	102.9	128.1	101.2	102.5	*

Table 3.6: Power forecast calculations for 7 periods ahead

Month	(a)X	(b) Predicted (trend) power	(c) Seasonal index (%)	(d) =(b).(c) estimated power with trend & seasonal effects	(e) projected cyclic index (%)	(f) power forecast
Jan	85	233126.07	124	289076.33	123.1	355852.96
Feb	86	234075.61	119.2	279018.13	130.4	363839.64
Mar ch	87	235025.15	113.4	266518.52	89.1	237468
April	88	235974.69	114.5	270191.02	140.1	378537.62
May	89	236924.24	97.3	230527.29	149.3	344177.24
June	90	237873.78	73.9	175788.72	116.1	204090.7

Conclusion

Electricity demand forecasting represents the main task in the planning of electricity production because it determines the required resources to operate the electricity plants such as daily consumption of fuels. Furthermore, it is the corner stone of planning for electric plants and networks. Electric-Power forecasting is a dynamic process and requires frequent updates. This can be done with novel techniques and data, taking into consideration the principles involved. The methodologies currently used involve time series analyses with smoothing or moving average models, and less probabilistic forecasting models like Quantile regression models (QRMs), which are potential probabilistic techniques that could be adopted for predicting extreme power situations/conditions.

The points of significance and mathematical procedures discussed and shown in this paper are in the context of a business case. Therefore, such procedure may be utilized by businesses that have some degree of regularity to sales, to study and decompose the relevant components of sales variation. Once these components are understood, sales forecasts can be made for future periods by recombining these component effects into projected sales estimates, as illustrated in Table 3.6. By illustrating the procedure in a real business case situation, we have shown that combining mathematical calculations with management's firsthand knowledge of the situation can lead to logical and justified new power estimates. Finally, in view of the relative complexity of forecasting techniques, we recommend that management implements a simple forecasting method that is well understood. Power forecasting is a valuable resource for enhancing and promoting power services provision. This work is carried out to stimulate further discussions on standardizing electric-power forecasting approaches and methods, so that it can be used as a tool to facilitate power services delivery.

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OPTIMAL CONTROL OF INFECTIOUS DISEASES VIA VACCINATION, QUARANTINE AND TREATMENT: A THEORETICAL APPROACH

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Abstract

The focus of this paper is to examine the problem of controlling spread of infectious diseases through the use of Vaccines, quarantine and Treatment. Through the use of Pontryagin's maximum principle, we were able to ascertain the existence of the control systems. We also apply optimal control theory to minimizing the spread of infection in a population; the optimality was measured by the minimization of the probability of infectious individuals and maximization of the recovered individuals.

Keyword: *Optimal Control Theory, Pontryagin's maximum principle, Hamiltonian, Lagrangian, Infectious Diseases, Vaccination*

Introduction

Epidemiologist and Health workers all over the world are always seeking a way to eradicate infectious diseases in a given population. It has been noted that if proper and timely steps are taken in the course of an outbreak of a disease, eradication is possible. Notable ways of preventing or eradicating an infection include but not limited to (i) vaccination (ii) enlightenment campaign (iii) treatment etc.

Optimal control theory and its applications to models were first proposed by Pontryagin in the 1950s and improved on by Pontryagin et al (1986). Recently his work has been extended and used to make decisions in epidemiological models.

Optimal control theory is a useful tool that can be used to control the spread of a disease for which vaccine and /or treatment are available; see Yusuf and Benyah (2012), Zaman et al (2007), Zaman et al (2008) and Zaman et al (2009) for examples. The authors of aforementioned articles concentrated on the use of SIR models and they either applied optimal vaccination alone or with treatment, but in this study we applied the theory to a MSEIR model with standard incidence and we included quarantine as a control variable. The derivation and analysis of the MSEIR model used in this work can be found in Bolarin (2014).

Optimal Control

Optimal Vaccination

We consider the control variable $u(t) \in U_{\max}$ to be the percentage of susceptible individuals being vaccinated per unit time. Here,

$$U_{\max} = \{u \mid u(t) \text{ is lebesgue measurable, } 0 \leq u(t) \leq 0.87, t \in [0, T]\}.$$

Now we consider an optimal control problem to minimize the objective functional

$$J(u) = \int_0^T \left[A_1 M(t) + A_2 S(t) + A_3 E(t) + A_4 I(t) + \frac{1}{2} \kappa u^2(t) \right] dt \quad (1.1)$$

Subject to

$$\left. \begin{aligned}
 \frac{dM}{dt} &= K - (\delta + \alpha)M - \mu S \\
 \frac{dS}{dt} &= -\frac{\beta SI}{N} + \delta M + (\mu - \alpha - u(t))S + \rho R \\
 \frac{dE}{dt} &= \frac{\beta SI}{N} - (\varepsilon + \alpha)E \\
 \frac{dI}{dt} &= \varepsilon E - (\gamma + \alpha + \varphi)I \\
 \frac{dR}{dt} &= \gamma I - (\rho + \alpha)R + u(t)S(t) \\
 &\text{with} \\
 M(0) &= M_0 \geq 0 \\
 S(0) &= S_0 \geq 0 \\
 E(0) &= E_0 \geq 0 \\
 I(0) &= I_0 \geq 0 \\
 R(0) &= R_0 \geq 0
 \end{aligned} \right\} \quad (1.2)$$

$A_i (i = 1, 2, 3, 4)$ are small positive constants to keep a balance in the size of $M(t), S(t), E(t)$ and $I(t)$ respectively. κ is a positive weight parameter such that $0 < \kappa < N$ which is associated with the control $u(t)$. In this work, what we intend to do is to minimize the $M(t), S(t), E(t)$ and $I(t)$ classes and to maximize the total number of recovered class $R(t)$ using possible minimal control variable $u(t)$.

First, we show the existence for the control system (1.2). Let $M(t), S(t), E(t)$ and $I(t)$ be state variables with control variable $u(t)$. For existence, we consider a control system (1.2) with initial conditions. We rewrite (1.2) in the following form:

$$\phi_t = A\phi + F(\phi) \quad (1.3)$$

$$\text{where } \phi = \begin{bmatrix} M(t) \\ S(t) \\ E(t) \\ I(t) \\ R(t) \end{bmatrix}; \quad A = \begin{bmatrix} -(\delta + \alpha) & -\mu & 0 & 0 & 0 \\ \delta & (\mu - \alpha - u(t)) & 0 & 0 & \rho \\ 0 & 0 & -(\varepsilon + \alpha) & 0 & 0 \\ 0 & 0 & \varepsilon & -(\gamma + \alpha + \varphi) & 0 \\ 0 & u(t) & 0 & \gamma & -(\rho + \alpha) \end{bmatrix}$$

$$\text{and } F(\phi) = \begin{bmatrix} K \\ \frac{-\beta SI}{N} \\ \frac{\beta SI}{N} \\ 0 \\ 0 \end{bmatrix}$$

and ϕ_t denotes the derivatives of ϕ with respect to time t . (1.3) is a non-linear system with a bounded coefficient. We set

$$G(\phi) = A\phi + F(\phi) \tag{1.4}$$

The second term on the right hand side of (1.4) satisfies;

$|F(\phi_1) - F(\phi_2)| \leq D(|M_1(t) - M_2(t)| + |S_1(t) - S_2(t)| + |E_1(t) - E_2(t)| + |I_1(t) - I_2(t)|)$ where the positive constant D is independent of the state variables $M(t), S(t), E(t)$ and $I(t) \leq N(t)$.

Moreso,

$|G(\phi_1) - G(\phi_2)| \leq L|\phi_1 - \phi_2|$ where $L = \max\{D, \|A\|\} < \infty$. So it follows that G is uniformly Lipschitz continuous.

Following the argument to Birkhoff and Rota (1986), from definition of the control $u(t)$ and the restriction on $M(t), S(t), E(t), I(t)$ and $R(t) \geq 0$, we see that the solution of the system (1.3) exists.

In order to find the optimal solution of our control problems (1.1) and (1.2) we first find the lagrangian and Hamiltonian for the optimal control problem.

The lagrangian is given by;

$$L(M, S, E, I, u) = A_1M(t) + A_2S(t) + A_3E(t) + A_4I(t) + \frac{1}{2}\kappa u^2(t) \tag{1.5}$$

What we seek is the minimal value of (1.5). So we define the following Hamiltonian H for the control problem in order to achieve this.

$$H(M, S, E, I, R, u, \lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, t) = L(M, S, E, I, u) + \lambda_1(t) \frac{dM(t)}{dt} + \lambda_2(t) \frac{dS(t)}{dt} + \lambda_3(t) \frac{dE(t)}{dt} \left. \begin{array}{l} \lambda_4(t) \frac{dI(t)}{dt} + \lambda_5(t) \frac{dR(t)}{dt} \end{array} \right\} \tag{1.6}$$

Theorem 1

There exists an optimal control $u^*(t)$ such that $J(u^*(t)) = \min J(u(t))$ subject to the control (1.2) with initial conditions.

Proof:

We will use the result in Lukes (1982) to prove the existence of an optimal control. The control and the state variables are positive. In this minimizing problem, the necessary convexity of the objective functional in $u(t)$ is satisfied. The control space $U_{\max} = \{u | u(t) \text{ is lebesgue measurable and } 0 \leq u(t) \leq 0.87, t \in [0, T]\}$ is also convex and closed by definition. The optimal system is bounded which is the condition for compactness needed for the existence of the optimal control.

More so, the integral in the functional $A_1M(t) + A_2S(t) + A_3E(t) + A_4I(t) + \frac{1}{2}\kappa u^2(t)$ is convex on the control $u(t)$. Lastly there exist a constant $\nu > 1$, positive numbers ω_1 and ω_2 such that

$$J(u(t)) \geq \omega_2 + \omega_1(|u(t)|^2)^{\nu/2} \text{ which completes the existence of an optimal control.}$$

Now to find the optimal solution, we apply the Pontryagin's maximum principle as applied in Lenhart and John (2007) and Morton and Nancy (2000) to the Hamiltonian.

$$H(t, x(t), u(t), \lambda(t)) = f(t, x(t), u(t)) + \lambda(t)g(t, x(t), u(t)) \tag{1.7}$$

Lemma 1 (Zaman et al, 2008)

If $(x^*(t), u^*(t))$ is an optimal solution of an optimal control problem, then there exists a non-trivial vector function $\lambda(t) = (\lambda_1(t), \lambda_2(2), \dots, \lambda_n(t))$ satisfying the following inequalities:

$$\left. \begin{aligned} \frac{dx}{dt} &= \frac{\partial H(t, x^*(t), u^*(t), \lambda(t))}{\partial \lambda} \\ 0 &= \frac{\partial H(t, x^*(t), u^*(t), \lambda(t))}{\partial u} \\ \lambda'(t) &= \frac{\partial H(t, x^*(t), u^*(t), \lambda(t))}{\partial x} \end{aligned} \right\} \tag{1.8}$$

It follows from the derivation above that,

$$\left. \begin{aligned} u^* &= 0 \quad \text{if } \frac{\partial H}{\partial u} < 0 \\ 0 \leq u^* \leq 0.87 & \quad \text{if } \frac{\partial H}{\partial u} = 0 \\ u^* &= 0.87 \quad \text{if } \frac{\partial H}{\partial u} > 0 \end{aligned} \right\} \tag{1.9}$$

Now we apply the necessary conditions to the Hamiltonian (1.7).

Theorem 2

Let $M^*(t), S^*(t), E^*(t), I^*(t)$ and $R^*(t)$ be the optimal state solutions with associated optimal control variable $u^*(t)$ for the optimal control (1.1) and (1.2). Then there exist adjoint variables $\lambda_1, \lambda_2, \lambda_3, \lambda_4$ and λ_5 satisfying

$$\left. \begin{aligned} \lambda_1'(t) &= (\lambda_1(t) - \lambda_2(t))\delta + \alpha\lambda_1(t) - A_1 \\ \lambda_2'(t) &= \mu\lambda_1(t) + (\lambda_2(t) - \lambda_5(t))\frac{\beta I^*(t)}{N(t)} + (\alpha - \mu)\lambda_2(t) + (\lambda_2(t) - \lambda_5(t))u^*(t) - A_2 \\ \lambda_3'(t) &= \varepsilon(\lambda_3(t) - \lambda_4(t)) + \alpha\lambda_3(t) - A_3 \\ \lambda_4'(t) &= (\lambda_2(t) - \lambda_3(t))\frac{\beta S^*(t)}{N(t)} + (\gamma + \alpha + \varphi)\lambda_4(t) - \gamma\lambda_5(t) - A_4 \\ \lambda_5'(t) &= (\lambda_5(t) - \lambda_2(t))\rho + \alpha\lambda_5(t) \end{aligned} \right\} \tag{1.10}$$

with transversality conditions,

$$\lambda_i(T) = 0 \quad i = 1, 2, 3, 4, 5 \tag{1.11}$$

Furthermore, the optimal control $u^*(t)$ is given as

$$u^*(t) = \max \left\{ \min \left\{ \frac{S^*(t)(\lambda_2(t) - \lambda_5(t))}{\kappa}, 0.87 \right\}, 0 \right\} \quad (1.12)$$

Proof:

To determine the adjoint equations and the transversality conditions we use the Hamiltonian (1.6). By setting $M(t) = M^*(t), S(t) = S^*(t), E(t) = E^*(t), I(t) = I^*(t)$ and $R(t) = R^*(t)$ and differentiating the Hamiltonian (1.7) with respect to $M(t), S(t), E(t), I(t)$ and $R(t)$ we obtain,

$$\lambda_1'(t) = \frac{-\partial H}{\partial M} = (\lambda_1(t) - \lambda_2(t))\delta + \alpha\lambda_1(t) - A_1$$

$$\lambda_2'(t) = \frac{-\partial H}{\partial S} = \mu\lambda_1(t) + (\lambda_2(t) - \lambda_5(t))\frac{\beta I^*(t)}{N(t)} + (\alpha - \mu)\lambda_2(t) + (\lambda_2(t) - \lambda_5(t))u^*(t) - A_2$$

$$\lambda_3'(t) = \frac{-\partial H}{\partial E} = \varepsilon(\lambda_3(t) - \lambda_4(t)) + \alpha\lambda_3(t) - A_3$$

$$\lambda_4'(t) = \frac{-\partial H}{\partial I} = (\lambda_2(t) - \lambda_3(t))\frac{\beta S^*(t)}{N(t)} + (\gamma + \alpha + \varphi)\lambda_4(t) - \gamma\lambda_5(t) - A_4$$

$$\lambda_5'(t) = \frac{-\partial H}{\partial R} = (\lambda_5(t) - \lambda_2(t))\rho + \alpha\lambda_5(t)$$

Using the optimality conditions, we have

$$\frac{\partial H}{\partial u} = \kappa u^* - S^*(t)\lambda_2(t) + S^*(t)\lambda_5(t) = 0$$

$$\Rightarrow \kappa u^*(t) = S^*(t)(\lambda_2(t) - \lambda_5(t))$$

which gives

$$u^*(t) = \frac{S^*(t)(\lambda_2(t) - \lambda_5(t))}{\kappa} \quad (1.13)$$

from (1.9) and (1.13) we have

$$u^*(t) = \begin{cases} 0 & \text{if } \frac{S^*(t)(\lambda_2(t) - \lambda_5(t))}{\kappa} \leq 0 \\ \frac{S^*(t)(\lambda_2(t) - \lambda_5(t))}{\kappa}, & \text{if } 0 < \frac{S^*(t)(\lambda_2(t) - \lambda_5(t))}{\kappa} < 0.87 \\ 0.87 & \text{if } \frac{S^*(t)(\lambda_2(t) - \lambda_5(t))}{\kappa} \geq 0.87 \end{cases}$$

It can be rewritten in the following form
$$u^*(t) = \max \left\{ \min \left\{ \frac{S^*(t)(\lambda_2(t) - \lambda_5(t))}{\kappa}, 0.87 \right\}, 0 \right\}$$

The characterization of the optimal control is given by (1.12).

To obtain the optimal control and state we solve the optimality system consisting of the state system (1.2) with boundary conditions, the adjoint systems (1.10) and (1.11) and the characterization of the optimal control (1.12).

By substituting the values of $u^*(t)$ in the control system we get the following system

$$\left. \begin{aligned}
 \frac{dM^*(t)}{dt} &= K - (\delta + \alpha)M^*(t) - \mu S^*(t) \\
 \frac{dS^*(t)}{dt} &= -\frac{\beta S^*(t)I^*(t)}{N} + \delta M^*(t) + (\mu - \alpha)S^*(t) - S^*(t) \left(\max \left\{ \min \left\{ \frac{S^*(t)(\lambda_2(t) - \lambda_5(t))}{\kappa}, 0.87 \right\}, 0 \right\} \right) + \rho R \\
 \frac{dE^*(t)}{dt} &= \frac{\beta S^*(t)I^*(t)}{N} - (\varepsilon + \alpha)E^*(t) \\
 \frac{dI^*(t)}{dt} &= \varepsilon E^*(t) - (\gamma + \alpha + \varphi)I^*(t) \\
 \frac{dR^*(t)}{dt} &= \gamma I^*(t) - (\rho + \alpha)R^*(t) + S^*(t) \left(\max \left\{ \min \left\{ \frac{S^*(t)(\lambda_2(t) - \lambda_5(t))}{\kappa}, 0.87 \right\}, 0 \right\} \right)
 \end{aligned} \right\} (1.14)$$

with the Hamiltonian H^* at $(t, M^*, S^*, E^*, I^*, R^*, u^*, \lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5)$

$$\left. \begin{aligned}
 H^* &= M^*(t) + S^*(t) + E^*(t) + I^*(t) + \frac{1}{2} \left[\kappa \left(\max \left\{ \min \left\{ \frac{S^*(t)(\lambda_2(t) - \lambda_5(t))}{\kappa}, 0.87 \right\}, 0 \right\} \right)^2 \right] \\
 &+ \lambda_1(t) \left[K - (\delta + \alpha)M^*(t) - \mu S^*(t) \right] + \lambda_2(t) \left[-\frac{\beta S^*(t)I^*(t)}{N} + \delta M^*(t) + (\mu - \alpha)S^*(t) \right. \\
 &\quad \left. - S^*(t) \left(\max \left\{ \min \left\{ \frac{S^*(t)(\lambda_2(t) - \lambda_5(t))}{\kappa}, 0.87 \right\}, 0 \right\} \right) \right] + \rho R \\
 &+ \lambda_3(t) \left[\frac{\beta S^*(t)I^*(t)}{N} - (\varepsilon + \alpha)E^*(t) \right] + \lambda_4(t) \left[\varepsilon E^*(t) - (\gamma + \alpha + \varphi)I^*(t) \right] \\
 &+ \lambda_5(t) \left[\gamma I^*(t) - (\rho + \alpha)R^*(t) + S^*(t) \left(\max \left\{ \min \left\{ \frac{S^*(t)(\lambda_2(t) - \lambda_5(t))}{\kappa}, 0.87 \right\}, 0 \right\} \right) \right]
 \end{aligned} \right\} (1.15)$$

Optimal Vaccination and Treatment

We define our objective functional as;

$$J(u) = \int_0^T [A_1 M(t) + A_2 S(t) + A_3 E(t) + A_4 I(t)] dt + \frac{1}{2} \int_0^T (C_1 u_1^2 + C_2 u_2^2) dt$$

subject to

$$\begin{aligned} \frac{dM(t)}{dt} &= K - (\delta + \alpha)M(t) - \mu S(t) \\ \frac{dS(t)}{dt} &= -\frac{\beta S(t)I(t)}{N(t)} + \delta M(t) + (\mu - \alpha - u_1(t))S(t) + \rho R(t) \end{aligned} \tag{1.16}$$

$$\frac{dE(t)}{dt} = \frac{\beta S(t)I(t)}{N(t)} - (\varepsilon + \alpha)E(t)$$

$$\frac{dI(t)}{dt} = \varepsilon E(t) - (\gamma + \alpha + \varphi + u_2(t))I(t)$$

$$\frac{dR(t)}{dt} = \gamma I(t) - (\rho + \alpha) + u_1(t)S(t) + u_2(t)I(t)$$

where

$$U = \{(u_1(t), u_2(t)) \mid 0 \leq u_1 \leq u_{1\max} \leq 1, 0 \leq u_2 \leq u_{2\max} \leq 1, t \in [0, T]\} \tag{1.17}$$

and it is measurable in lebesque sense.

A_i for $i = 1, 2, 3, 4$ are small positive constant to keep a balance in the size of our compartments.

C_1 and C_2 are the relative weights attached to the cost of the interventions. u_1 and u_2 are proportions of vaccinated susceptible and treated infected respectively.

Following the approach above we have;

For existence:

Let $M(t), S(t), E(t)$ and $I(t)$ be the state variables with a control variable u (as given in 1.17). For existence we consider a control system (1.16) with initial conditions. We can rewrite (1.16) in the following form

$$\phi_t = A\phi + F(\phi) \tag{1.18}$$

Where

$$\phi = \begin{bmatrix} M(t) \\ S(t) \\ E(t) \\ I(t) \\ R(t) \end{bmatrix};$$

$$A = \begin{bmatrix} -(\delta + \alpha) & -\mu & 0 & 0 & 0 \\ \delta & (\mu - \alpha - u(t)) & 0 & 0 & \rho \\ 0 & 0 & -(\varepsilon + \alpha) & 0 & 0 \\ 0 & 0 & \varepsilon & -(\gamma + \alpha + \varphi + u_2) & 0 \\ 0 & u(t) & 0 & (\gamma + u_2) & -(\rho + \alpha) \end{bmatrix}$$

$$F(\phi) = \begin{bmatrix} K \\ \frac{-\beta SI}{N} \\ \frac{\beta SI}{N} \\ 0 \\ 0 \end{bmatrix}$$

and ϕ_t denote the derivative of ϕ with respect to time t . As we know (1.18) is a non-linear system with a bounded coefficient. Now we have

$$G(\phi) = A\phi + F(\phi) \tag{1.19}$$

The second term on the RHS of (1.19) satisfies

$$|F(\phi_1) - F(\phi_2)| \leq L (|M_1(t) - M_2(t)| + |S_1(t) - S_2(t)| + |E_1(t) - E_2(t)| + |I_1(t) - I_2(t)|) \quad \text{where } L \text{ (positive constant) is independent of the state variable } M(t), S(t), E(t) \text{ and } I(t) \leq N(t) .$$

More so,

$$|G(\phi_1) - G(\phi_2)| \leq H |\phi_1 - \phi_2| \quad \text{where } H = \max\{L, \|K\|\} \text{ with restriction on}$$

$M(t), S(t), E(t), I(t)$ and $R(t) \geq 0$ and the definition of u , we can see that the solution of the system (1.16) exists and G is uniformly Lipschitz continuous.

To find the optimal solution of (1.16) and (1.17) we find the Lagrangian and Hamiltonian for the optimal control problem.

The Lagrangian is given by,

$$L(M, S, E, I, U) = A_1 M(t) + A_2 S(t) + A_3 E(t) + A_4 I(t) + \frac{1}{2} C_1 u_1^2 + C_2 u_2^2 \tag{1.20}$$

We seek the minimal value of (1.20). So we define the following Hamiltonian H for the control problem.

$$H(M, S, E, I, R, u, \lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, t) = L(M, S, E, I, u) + \lambda_1(t) \frac{dM(t)}{dt} + \lambda_2(t) \frac{dS(t)}{dt} + \lambda_3(t) \frac{dE(t)}{dt} \left. \vphantom{H} \right\} \lambda_4(t) \frac{dI(t)}{dt} + \lambda_5(t) \frac{dR(t)}{dt} \tag{1.21}$$

Theorem 3

Let $M^*(t), S^*(t), E^*(t), I^*(t)$ and $R^*(t)$ be optimal state solutions with associated optimal control pair $u_1^*(t)$ and $u_2^*(t)$ for the optimal control problem (16) and (17) then there exists an adjoint variables $\lambda_1, \lambda_2, \lambda_3, \lambda_4$ and λ_5 which satisfy:

$$\left. \begin{aligned}
 \lambda_1'(t) &= \frac{-\partial H}{\partial M} = (\lambda_1(t) - \lambda_2(t))\delta + \alpha\lambda_1(t) - A_1 \\
 \lambda_2'(t) &= \frac{-\partial H}{\partial S} = \mu\lambda_1(t) + (\lambda_2(t) - \lambda_5(t))\frac{\beta I^*(t)}{N(t)} + (\alpha - \mu)\lambda_2(t) + (\lambda_2(t) - \lambda_5(t))u_1^*(t) - A_2 \\
 \lambda_3'(t) &= \frac{-\partial H}{\partial E} = \varepsilon(\lambda_3(t) - \lambda_4(t)) + \alpha\lambda_3(t) - A_3 \\
 \lambda_4'(t) &= \frac{-\partial H}{\partial I} = (\lambda_2(t) - \lambda_3(t))\frac{\beta S^*(t)}{N(t)} + (\lambda_4 - \lambda_5)\gamma + (\alpha + \varphi)\lambda_4(t) + (\lambda_4 - \lambda_5)u_2^* - A_4 \\
 \lambda_5'(t) &= \frac{-\partial H}{\partial R} = (\lambda_5(t) - \lambda_2(t))\rho + \alpha\lambda_5(t)
 \end{aligned} \right\} (1.22)$$

with transversality conditions $\lambda_i(T) = 0 \quad i = 1, 2, 3, 4, 5$ (1.23)

Further more, the optimal control $u = (u_1^*, u_2^*)$ is given as

$$\left. \begin{aligned}
 u_1^*(t) &= \max \left\{ \min \left\{ 0, \frac{S^*(t)(\lambda_2(t) - \lambda_5(t))}{C_1}, u_{1\max} \right\}, 0 \right\} \\
 u_2^*(t) &= \max \left\{ \min \left\{ 0, \frac{I^*(t)(\lambda_4(t) - \lambda_5(t))}{C_5}, u_{2\max} \right\}, 0 \right\}
 \end{aligned} \right\} (1.24)$$

Proof:

From (21) our Hamiltonian is given as

$$\begin{aligned}
 &\frac{1}{2}(C_1 u_1 + C_2 u_2) + A_1 M(t) + A_2 S(t) + A_3 E(t) + A_4 I(t) + \lambda_1(A - (\delta + \alpha)M(t) - \mu S(t)) \\
 &+ \lambda_2 \left(\frac{-\beta S(t)I(t)}{N} + \delta M + (\mu - \alpha - u_1)S(t) + \rho R(t) \right) + \lambda_3 \left(\frac{\beta S(t)I(t)}{N} - (\varepsilon + \alpha)E(t) \right) \\
 &+ \lambda_4 (\varepsilon E(t) - (\gamma + \alpha + \varphi + u_2)I(t)) + \lambda_5 (\gamma I(t) - (\rho + \alpha)R(t) + u_1 S(t) + u_2 I(t))
 \end{aligned}$$

So from the third equation of system (8) and by setting $M(t) = M^*(t), S(t) = S^*(t), E(t) = E^*(t), I(t) = I^*(t)$ and $R(t) = R^*(t)$ we have

$$\left. \begin{aligned}
 \lambda_1'(t) &= \frac{-\partial H}{\partial M} = (\lambda_1(t) - \lambda_2(t))\delta + \alpha\lambda_1(t) - A_1 \\
 \lambda_2'(t) &= \frac{-\partial H}{\partial S} = \mu\lambda_1(t) + (\lambda_2(t) - \lambda_5(t))\frac{\beta I^*(t)}{N(t)} + (\alpha - \mu)\lambda_2(t) + (\lambda_2(t) - \lambda_5(t))u_1^*(t) - A_2 \\
 \lambda_3'(t) &= \frac{-\partial H}{\partial E} = \varepsilon(\lambda_3(t) - \lambda_4(t)) + \alpha\lambda_3(t) - A_3 \\
 \lambda_4'(t) &= \frac{-\partial H}{\partial I} = (\lambda_2(t) - \lambda_3(t))\frac{\beta S^*(t)}{N(t)} + (\lambda_4 - \lambda_5)\gamma + (\alpha + \varphi)\lambda_4(t) + (\lambda_4 - \lambda_5)u_2^* - A_4 \\
 \lambda_5'(t) &= \frac{-\partial H}{\partial R} = (\lambda_5(t) - \lambda_2(t))\rho + \alpha\lambda_5(t)
 \end{aligned} \right\}$$

Now the Hamiltonian is maximized with respect to controls at the optimal control pair.

So by optimality conditions, we have

$$\frac{\delta H}{u_1} = 0 \quad \text{and} \quad \frac{\delta H}{u_2} = 0$$

$$\Rightarrow \left. \begin{aligned} C_1 u_1 - \lambda_2 S(t) + \lambda_5 S(t) &= 0 \\ C_2 u_2 - \lambda_4 I(t) + \lambda_5 I(t) &= 0 \end{aligned} \right\} \quad (1.25)$$

which gives

$$\left. \begin{aligned} u_1 &= \frac{(\lambda_2 - \lambda_5)S(t)}{C_1} \\ u_2 &= \frac{(\lambda_4 - \lambda_5)I(t)}{C_2} \end{aligned} \right\} \quad (1.26)$$

by setting $u_1(t) = u_1^*(t), u_2(t) = u_2^*(t), S(t) = S^*(t)$ and $I(t) = I^*(t)$, from (25) we have

$$\left. \begin{aligned} u_1^* &= \frac{(\lambda_2 - \lambda_5)S^*(t)}{C_1} \\ u_2^* &= \frac{(\lambda_4 - \lambda_5)I^*(t)}{C_2} \end{aligned} \right\}$$

So if we impose the bounds $0 \leq u_1 \leq u_{1\max}$ and $0 \leq u_2 \leq u_{2\max}$, in compact form we have

$$\left. \begin{aligned} u_1^*(t) &= \max \left\{ \min \left\{ 0, \frac{S^*(t)(\lambda_2(t) - \lambda_5(t))}{C_1}, u_{1\max} \right\}, 0 \right\} \\ u_2^*(t) &= \max \left\{ \min \left\{ 0, \frac{I^*(t)(\lambda_4(t) - \lambda_5(t))}{C_5}, u_{2\max} \right\}, 0 \right\} \end{aligned} \right\}.$$

So we have (16) and (22) as our resulting optimality system.

Quarantine, Vaccination and Treatment

We now consider an additional optimality parameter, quarantine.

Define the objective function as:

$$J(u) = \int_0^T [A_1 M(t) + A_2 S(t) + A_3 E(t) + A_4 I(t)] dt + \frac{1}{2} \int_0^T (C_1 u_1^2 + C_2 u_2^2 + C_2 u_2^2) dt$$

subject to

$$\begin{aligned} \frac{dM(t)}{dt} &= K - (\delta + \alpha)M(t) - \mu S(t) \\ \frac{dS(t)}{dt} &= -\frac{\beta S(t)I(t)}{N(t)} + \delta M(t) + (\mu - \alpha - u_1(t))S(t) + \rho R(t) \\ \frac{dE(t)}{dt} &= \frac{\beta S(t)I(t)}{N(t)} - (\varepsilon + \alpha)E(t) \\ \frac{dI(t)}{dt} &= \varepsilon E(t) - (\gamma + \alpha + \varphi + u_2(t))I(t) \\ \frac{dR(t)}{dt} &= \gamma I(t) - (\rho + \alpha) + u_1(t)S(t) + u_2(t)I(t) + u_3 R(t) \end{aligned} \quad (1.27)$$

where

$$U = \left\{ (u_1(t), u_2(t)), u_3(t) \mid 0 \leq u_1 \leq u_{1\max} \leq 1, 0 \leq u_2 \leq u_{2\max} \leq 1, 0 \leq u_3 \leq u_{2\max} \leq 1, t \in [0, T] \right\} \quad (1.28)$$

A_i for $i = 1, 2, 3, 4$ are small positive constant to keep a balance in the size of our compartments.

C_1, C_2 and C_3 are the relative weights attached to the cost of the interventions. u_1, u_2 and u_3 are proportions of vaccinated susceptible, quarantine exposed and treated infected respectively.

Similarly, we can show the existence for the optimality system by following the reasoning above.

To find the optimal solution of (1.27) and (1.28) we find the Lagrangian and Hamiltonian for the optimal control problem.

The Lagrange is given by

$$L(M, S, E, I, U) = A_1M(t) + A_2S(t) + A_3E(t) + A_4I(t) + \frac{1}{2}C_1u_1^2 + C_2u_2^2 + C_3u_3^2 \quad (1.29)$$

We seek the minimal value of (1.29), so we define the following Hamiltonian H for the control problem.

$$H(M, S, E, I, R, u, \lambda_1, \lambda_2, \lambda_3, \lambda_4, \lambda_5, t) = L(M, S, E, I, u) + \lambda_1(t) \frac{dM(t)}{dt} + \lambda_2(t) \frac{dS(t)}{dt} + \lambda_3(t) \frac{dE(t)}{dt} + \lambda_4(t) \frac{dI(t)}{dt} + \lambda_5(t) \frac{dR(t)}{dt} \quad (1.30)$$

Theorem 4

Let $M^*(t), S^*(t), E^*(t), I^*(t)$ and $R^*(t)$ be optimal state solutions with associated optimal control pair $u_1^*(t)$ and $u_2^*(t)$ for the optimal control problem (1.16) and (1.17) then there exists an adjoint variables $\lambda_1, \lambda_2, \lambda_3, \lambda_4$ and λ_5 which satisfy:

$$\left. \begin{aligned} \lambda_1'(t) &= \frac{-\partial H}{\partial M} = (\lambda_1(t) - \lambda_2(t))\delta + \alpha\lambda_1(t) - A_1 \\ \lambda_2'(t) &= \frac{-\partial H}{\partial S} = \mu\lambda_1(t) + (\lambda_2(t) - \lambda_5(t))\frac{\beta I^*(t)}{N(t)} + (\alpha - \mu)\lambda_2(t) + (\lambda_2(t) - \lambda_5(t))u_1^*(t) - A_2 \\ \lambda_3'(t) &= \frac{-\partial H}{\partial E} = \varepsilon(\lambda_3(t) - \lambda_4(t)) + \alpha\lambda_3(t) + (\lambda_3(t) - \lambda_5(t))u_2^*(t) - A_3 \\ \lambda_4'(t) &= \frac{-\partial H}{\partial I} = (\lambda_2(t) - \lambda_3(t))\frac{\beta S^*(t)}{N(t)} + (\lambda_4 - \lambda_5)\gamma + (\alpha + \varphi)\lambda_4(t) + (\lambda_4 - \lambda_5)u_3^* - A_4 \\ \lambda_5'(t) &= \frac{-\partial H}{\partial R} = (\lambda_5(t) - \lambda_2(t))\rho + \alpha\lambda_5(t) \end{aligned} \right\} (1.31)$$

with transversality conditions $\lambda_i(T) = 0 \quad i = 1, 2, 3, 4, 5$ (1.32)

Proof:

The proof follows from Theorem 3

Conclusion

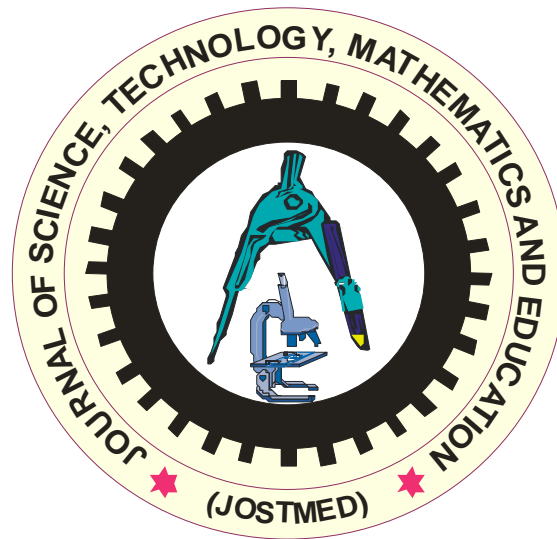
In this work a MSEIR model was used to study application of optimal control technique to epidemiology. Pontryagin's Maximum Principle was used in this work. We have shown the existence of the control systems, where we focused on the application of optimal control theory to minimizing the spread of measles in a population, the optimality was measured by

the minimality of the probability of infectious individuals and maximization of the recovered individuals. We derived the necessary conditions for the control problems by studying three scenarios namely; (i) Vaccination alone (ii) Vaccination and Treatment (iii) Vaccination, Quarantine and Treatment.

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**ARTICLES AND RESEARCH REPORTS
ON EDUCATION**

RELIGIOUS COMMITMENT AS A PREDICTOR OF SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND ATTITUDE TO POPULATION EDUCATION CONCEPTS IN BIOLOGY IN KATSINA STATE, NIGERIA

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Abstract

The study investigated students' religious commitment as a predictor of secondary school students' achievement and attitude to population education concepts in Biology in Katsina State. A descriptive survey was used in the study. A sample of three hundred and fourteen students (314) from six randomly selected secondary schools was used for the study. Three instruments were used to collect data: (i) Students' Religious Commitment Questionnaire (SRCQ), (ii) Students' Attitude to population Education Questionnaire (SAPEQ) and (iii) Population Education Achievement Test (PEAT). The test retest reliability yielded 0.784, 0.713 and 0.816 coefficients for SRCQ, SAPEQ and PEAT respectively. Data were analyzed using Linear Regression, Pearson Product-Moment Correlation and t-test statistics. The findings show that students' religious commitment accounted for 0.2% of total variance in achievement to population education concepts in biology ($R^2 = .002$, $p < 0.05$). Students' religious commitment also, accounted for 4.0% of the total variance in students' attitude to population education ($R^2 = 0.04$, $p < 0.05$). There was a positive and significant relationship between students' religious commitment and attitude to population education ($r = .200$, $p < 0.05$). There was a negative and no significant relationship between students' religious commitment and achievement to population ($r = .040$, $p < 0.05$). However, there was a positive but no significant relationship between students' religious commitment and achievement in population education ($r = .032$, $p < 0.05$). There was no significant differences between male and female students' religious commitment and achievement in population education ($t = 0.437$, 0.502 , $p > 0.05$). However, there was a significant difference between male and female students' attitude to population education. It was recommended among others that students' religious commitment should not be used to determine students' achievement in population education concepts in Biology.

Keywords: *Achievement, Attitude, Religious commitment, population education, secondary school students*

Introduction

There is a striking paradox in the world population growth. National Population Commission (NPC), (2006) said that the population of Nigeria is about 140 million. With this figure, Nigeria is tagged the most populous country in Africa as asserted by the World Bank (2003). Moreover, with about 3.2 percent growth increase in the population, in the next 23 years the 140 million estimated population for the year 2006 will be doubled (Obasanjo, 2007). The human population is forever growing (Kassuba, 2002). Initially, the world population growth was slow. It took millions of years to get the first billion of human beings on the earth by 1850. Then it took 80 years to add another billion by 1930, and only 30 years more to add a third billion by 1961. However, it took only 16 years to add the fourth billion by 1976. Also, within fourteen years 1976 to 1990, another one billion people were added (Olasehinde, 2008).

The world's population is now odds-on to swell ever-higher for the rest of the century, posing grave challenges for food supplies, healthcare and social cohesion. A ground-

breaking analysis released shows that there is a 70% chance that the number of people on the planet will rise continuously from 7bn to 11bn in 2100 (Carrington, 2014).

There is need to express concern due to the fact that those numbers that kept on multiplying were not just from birth alone, but from the decline in older people dying. People are living for a longer period of time because of better food, house and medical improvement. The death rate among children was once much higher than it is today. Sciences especially medicine have reduced the death rate by controlling disease and epidemics. Vaccination, antibodies, and insecticides are used throughout the world to prevent and cure diseases. There are more children living until they are old enough to reproduce. As more people reproduce, more children are born and population keeps on increasing.

Population Report (2007) projected a world population of 8.04 billion for the year 2025 and 9.37 billion for 2050. According to this medium variant, an increase of some 2.35 billion people is expected worldwide between 1996 and 2025. This projection was based on the assumption that almost all countries worldwide will have a Total Fertility Rate (TFR) of only 2.1 in 2050, that is, a little less between 1.84 and 2.1. This assumption would require a further steep fertility decline in many developing nations especially in Pakistan, Iran, Indian and Nigeria where the total fertility rate is above the reproductive level of 2.1 children per woman (The World Bank, 2003).

Population education has been defined as an educational program which provides for a study of the population situation in the family, the community, the nation and the world with the purpose of developing in the students, rational and responsible attitude and behaviour toward that situation. Also, Monika (2013) defines population education as the educational process by which basic awareness about population problem and a favorable attitude towards a small family size is developed through school and colleges. So far we have adopted a limited approach to this population education in Nigeria a visit to the National Population Commission in Nigeria shows no evidence of educating the populace about population. It is not also, a subject on the of the secondary school curriculum in Nigeria where most teenagers need it to equip themselves for their futures. The concepts of population education are infused into subjects such as Biology, Chemistry, Economics, Agricultural Science and some others where the students can pick ideas of population education.

In some developing countries population education has been linked with educational reform. Reform means introducing a new subject matter relevant to modern life and encouraging new teaching methods that stimulate more students' participation. Population education takes various forms. The most comprehensive approach is through the government-operated primary and secondary school system.

Stevens (2007) notes that religion is an extremely powerful motivator of behaviours and it forms a strong basis for cultural identity, just as it is a common yardstick by which people compare themselves with others. Religion, among other things, provides explanation or comfort and unifies the different social groups. Religious instructions can therefore help to structure people's lives. Religion cannot be separated from culture since every culture has its own religion(s). Any belief embraced by any religion can therefore be passed into the cultural system even in multi-religious and multi-lingual societies like Nigeria.

Commitment is any type of deposition, behaviour or attribute. In another way, it is when an alternative is voluntarily available or mandated by others. Commitment can be described as the level of people's devotion to whatever they are doing. Wimberley (1978) defines

commitment as a process. He explains that in the process one needs among the alternatives of which he or she is aware or has alternatives selected by others. He further remarks that commitment is pursued with commitment strength to realise the set goals.

Religion commitment is predictive of greater prosocial behaviour (Hardy & Carlo, 2005), less depression (Pearce, Little, & Perez, 2003), less substance use (Wills, Yaeger, & Sandy, 2003), and postponed sexual intercourse (Hardy & Raffaelli, 2003). There are a number of possible reasons for these associations. For example, religion teaches prosocial values (Hardy & Carlo, 2005), and provides social controls (Hardy & Raffaelli, 2003) and social capital (King & Roeser, 2009). In Nigeria, for example, many people have claimed that their religions have transformed their lives. Religion therefore, can probably be harnessed to transform some bad behaviour in human beings. Many studies have reported that religion reduces the tendency towards or incidence of deviant and immoral behaviors (Olatoye, 2007). However, Johnson (2001) reported no significant relationship between religious commitment and incidence of deviant behaviors. This implies that, religious commitment may have nothing to do with expression of good behaviors. Similarly, Gledhill (2005) reported that religious belief can cause damage to a society, contributing towards high abortion and sexual promiscuity. This further explains that higher rates of religious commitment and worship of a creator correlate with higher rates of sexually transmitted diseases (STD) infection rates, teenage pregnancy and abortion.

Christian and Islamic dogmas encouraged women to be taught more in areas that make them mothers and wives. The purdah system practiced by Islam is an extreme case of shielding women from population education. Some religious practices, Islam for example indirectly support a man having up to four wives with so many children, the result of which is a large family (Aderogba & Olatoye, 2012). It is also, understandable that all major religious groups in Nigeria, Moslems, Christians and ancestor worshippers tend to hold similar views and beliefs on population education especially fertility rate. They all tend to see large number of children as a divine favour or blessing.

Religious commitment and academic achievement has been the focus of researchers in the recent time. Some researchers were of the opinion that the higher the religious commitment the higher the academic achievement while others reported that the higher the religion commitment the lower the academic achievement of the students. Walker and Dixon (2002) reports that religiosity is positively correlated with grade point average of the students. Jeynes (2005) asserts that religious schooling and religious commitment each has a positive effect on academic achievement and school related behavior. Loury (2004) also found that religiously committed students perform better on most academic measure than did their less religious counterpart. Mooney (2005) stated that religiosity correlated with academic achievement. Jeynes (2005) states that religious affiliated schools promote academic achievement more than the public schools. Contrary to these positive opinions Richard (2011) asserts that neither Christian nor public school students have higher total score in examinations. He went further to state that there is no significant difference between the scores of the private Christian and public schools' students. Richard (2011) affirms that researches that indicated positive correlation between academic achievement and religiosity may not be universal.

Attitude does not only include the negative attitude such a prejudices biases and dislikes. It also encompasses also positive attitudes which are sometimes called sentiment, which include our attachment and loyalties to person, objects and ideas (George, 2000). Attitude thus seems like a system of ideas with an emotional core or content. An individual possesses his or her life, he or she acquires not only skills and knowledge, but also definite attitudes,

point of views and feelings about his or her experiences. These definite attitudes, point of views and feelings are developed not only due to what kind of experiences the individual passes through, but also how these experiences came about. Olasehinde and Olatoye (2014) assert that attitude to science alone also has a total variance of 0.1% on science achievement. It denotes that positive attitude to science does not imply that the students will have high science achievement. They note that the widely believed submission that attitude to science greatly predict achievement in science is unfounded. Amjad and Muhammad (2012) asserted that students have low level performance and less favourable attitude towards population related issues.

Less positive attitude of females toward science than males is reported in many studies. Also, Raimi and Adeoye (2002) reported that there is a significant difference between males and females in terms of their attitude towards integrated science in favour of male. Perhaps, this has been the reasons for males' better performance in integrated science cognitive achievement. Olasehinde and Olatoye (2014) reported no significant difference between the male and female students' attitude to science and science achievement. This implies that there no serious gender disparity among the male and female students. The results of male and female students also reveal very low performance of students in science. Olasehinde (2008) asserts that there is no significant difference between the attitude of boys and girls in population issues. Based on above literature this study therefore, investigated religious commitment and secondary school students' attitude to population education concepts in Biology.

Hypotheses

The following hypotheses were tested at 0.05 level of significance:

- (i) Religious commitment does not significantly influence students' achievement in population education concepts in Biology.
- (ii) Religious commitment do not significantly influence students' attitude to population education concepts in Biology.
- (iii) There is no significant relationship between religious commitment, achievement and attitude to population education concepts in Biology.
- (iv) There is no significant difference between male and female students'
 - (i) Religious Commitment;
 - (ii) Attitude to Population Education Concepts in Biology and
 - (iii) Achievement in population education concepts in biology.

Methodology

This study adopted a descriptive survey research design. The entire Senior Secondary School Students (girls and boys) taking Biology in all the public secondary schools in Katsina State, Nigeria is the target population for this study. A multi-stage stratified random sampling technique was used. The first stage involved stratification or division of the whole state into three Educational zones. The second stage is to randomly select two local governments from each selected zones of the state for the study. The third stage involved the selection two senior secondary schools from each LGA. Thus, six secondary schools were selected from the state. The fourth stage involved selection of SSII class in each of the randomly selected schools. In each of the SSII class selected an intact class was used for the research.

Three instruments were used to collect data for this study. They are: (i) Students' Religious Commitment Questionnaire (SRCQ); (ii) Students' Attitude to Population Education Questionnaire (SAPEQ) and (iii) Population Education Achievement Test (PEAT).

SRCQ and SAPEQ were designed by the researcher. Each of these questionnaires has 12 items with a four-point Likert-type scale of 'Strongly Agree', 'Agree', 'Disagree' and 'Strongly Disagree'. The respondents were asked to indicate their feelings to each statement/item by ticking any of the four possible responses on the scale. The items on the instruments covered different aspects of the variables being considered. Respondents were asked to indicate their gender and type of school on the questionnaires.

The validity of the three questionnaires and the achievement tests were ensured through experts' suggestions and guidance. All the achievement items were selected from already standardized items produced by the West African Examination Council. The items selected were only on the items covered in all the schools selected for the study. The test retest reliability yielded 0.784, 0.713 and 0.816 coefficients for SRCQ, SAPEQ and PEAT respectively.

Data were analyzed using Statistical Package for Social Sciences (SPSS). Research hypotheses 1 and II were tested using Linear Regression. Research hypothesis III was tested using Pearson-Moment Coefficient. Research hypothesis IV was answered using t-test.

Results

Hypothesis 1: Religious commitment does not significantly influence students' achievement in population education concepts in Biology.

Table I: Religious commitment as a predictor to students' achievement in population education concept in Biology

Model	Sum of Square	df	Mean Square	F	Sig
Regression	3.989	1	3.989	.498	.481
Residual	2505.198	313	8.004		
Total	2509.187	314			

Table I show that religious commitment accounted for 0.20% of the total variance in the students' achievement in population education concepts in Biology. ($R^2 = 0.002$, $P < 0.05$). This shows that the influence of religious commitment is positive but low on the students' achievement in Biology. The 99.8 of variance in achievement accounted for by other variables.

Hypothesis 2: Religious commitment does not significantly influence students' attitude to population education concepts in Biology.

Table 2: Religious Commitment as a Predictor to Students' Attitude to Population Education Concept in Biology

Model	Sum of Square	df	Mean Square	F	Sig
Regression	1180.272	1	1180.272	.498	.481
Residual	28262.699	313	90.296	13.071	.000
Total	29442.971	314			

Table 2 shows that religious commitment accounted for 4.0% of the total variance in attitude to population education concept in Biology ($R^2 = 0.040$, $P < 0.05$). This shows that religion commitment have positive influence on attitude of students' to population education. The rest 96% of the variance belong to the variable that is not considered.

Hypothesis 3: There is no significant relationship between religious commitment, achievement and attitude to population education concepts in biology.

Table 3: Relationship between students' religious commitment, achievement and attitude to population education concepts in Biology

Variable	Students' Religious Commitment	Students' Attitude to Population Education	Students' Achievement in Population Education
Students' Religious Commitment			-.040
Pearson Correlation	1	.200**	.481
Sig (2-tailed)		.000	.315
N		315	
	315		
Students' Attitude to Population Education			
Pearson Correlation	.200**	1	.032
Sig. (2-tailed)			.568
N	.000	315	315
	315		
Students' Achievement in Population Education			
Pearson Correlation	-.040	.032	1
Sig. (2-tailed)	.481	.568	
N	315	315	315

** Correlation is significant at the 0.01 level (2-tailed)

Table 3 shows that there is a positive relationship and significant relationship between students' religious commitment and attitude to population education ($r = .200$, $p < 0.05$). There is also a negative but no significant relationship between religious commitment and achievement in population education ($r = -.040$, $p > 0.05$). However, there is a positive but no significant relationship between students' attitude and achievement in population education ($r = .032$, $p < 0.05$).

Hypothesis 4: There is no significant difference between male and female students'

- (i) Religious Commitment;
- (ii) Attitude to Population Education Concepts in Biology, and
- (iv) Achievement in population education concepts in Biology.

Table 4: Comparison of Male and Female Students' Religion Commitment, Attitude to Population Education and Achievement in Population Education

Variable	Gender	N	Mean	Std Dev	Std Error	df	t	P-value
Students' Religious Commitment	Male	192	39.9323	7.06667	.50999	312	.437	.650
	Female	122	39.5328	8.38080	.75874			
Students' Attitude to Population Education	Male	192	30.7240	10.72170	.77377	312	-3.187	.002
	Female	122	34.2459	7.29464	.66043			
Students' Achievement in Population Education	Male	192	8.3281	2.62721	.18960	312	.502	.616
	Female	122	8.1639	3.11053	.28161			

Sig at P < 0.05

Table 4 shows that there is no significant difference between male and female students' commitment and achievement in population education ($t = 0.437, 0.502, p > 0.05$). It further shows that there is a significant difference between the male and female students attitude to population education ($t = -3.187, p, 0.05$).

Discussion

Religious commitment accounted for 0.20% of the total variance of students' achievement in population education concepts in Biology. The variance is low and not significant. This shows that the students have low level of religious commitment and that religious commitment has low effect on achievement on population education concepts in Biology. This implies that religion has no effect on population growth and supports Aderogba and Olatoye (2012) submission that all religions clamor for more children in the family. Also, this supports Gledhill (2005) that religious beliefs can cause damage to a society, contributing towards high abortion and sexual promiscuity. This further explains that the higher rate of religious commitment and worship of a creator correlates with high rate of STD infection, teenage pregnancy and abortion.

Furthermore, findings in the study show that Religious commitment accounted for 4.0% of the total variance of students' attitude to population education concepts in Biology. The percentage of the variance is very low and not significant. Aderogba and Olatoye, (2012) affirms that positive attitude will lead to higher achievement. That is, those with positive attitude towards a course or subject will have higher achievement in the course or subject and vice versa. Students' positive attitude towards population education concepts will make them have intrinsic motivation which is an inherent quality to propel greater achievement in Biology.

The result of the study further shows a negative but no significant relationship between religious commitment and achievement in population education concept in biology. This shows that the higher the students' religious commitment the lower the students' achievement in population education concepts in Biology and the lower the students' religious commitment the higher the students' achievement.

The result went further to show that there is a positive but significant relationship occurred between the students' religious commitment and achievement in population education concepts in Biology. This implies that the higher the students' religious commitment the higher the students' achievement in population education concepts in Biology the lower the students' religious commitment the lower the students' achievement in population education

concept in Biology. However, there is a positive and no significant relationship between students' attitude to population education and achievement in population education concepts in Biology. This shows that the higher the students' attitude to population education the higher the students' achievement in population education concepts in Biology and the lower the students' attitude to population education the lower the students' achievement in population education concept in Biology.

The male and female students' religious commitment, attitude to population education, achievement in population education was compared. The findings show that there was no significant difference between male and female students' religious commitments and students' achievement in population education concept in Biology. However, the result shows that the male students have means score ($\bar{X} = 39.9323$) and female students with ($\bar{X} = 39.5328$) in religion commitment. This supports Olatoye and Afuwape (2012) that male students have higher religious commitments than the female students. Also, the male students have the mean score ($\bar{X} = 8.3281$) while the female students have the mean score of ($\bar{X} = 8.1639$) in achievements in population education concepts in Biology. This supports Olagunju and Olasehinde (2011) views that the male students have higher scores in population education concepts than the female students.

Furthermore, there is significant difference between male and female students' attitudes to population education concepts in Biology. The significant difference is as a result of the female students having higher mean score ($\bar{X} = 34.2459$) as against the male students mean score ($\bar{X} = 30.7240$). This supports Olasehinde and Olatoye (2014) positions that female students have more positive attitude to biology than the male students and against Kavita (2002) that, there is no significant difference between male and female attitude to population issues.

Conclusion

Population problem is a matter of great concern and is closely related to development of individual, family and the society. The findings in this study revealed that religious commitment accounted for very low variance in students' achievement and attitude to population education concepts in Biology. There is a negative and no significant relationship between students' religious commitment and students' achievement in population education concepts in Biology. A positive and significant relationship occurred between religious commitment and students' attitude to population education. Also, there is a positive but no significant relationship between students' attitude and achievement in population education concepts in Biology.

Furthermore, the findings revealed that there is no significant difference between male and female students' religious commitment and achievement in population education concepts in Biology. However, there is a significant difference between male and female students' attitude to population education concepts in Biology.

Recommendations

The following recommendations are made:

- (i) Religious commitment should not be used to determine the students' achievement in population education concepts in Biology.
- (ii) Religious commitment should not be used to determine the students' attitude to population education concepts in Biology.
- (iii) Education stakeholders should encourage both genders to develop positive attitude to population education.

- (iv) The negative and no significant relationship between students' religious commitment and achievement in population education should be used to promote population education among the religious in secondary schools.
- (v) The significant relationship between students' religious commitment and attitude to population education should be used to help the students develop a positive attitude to population education concepts no matter the level of religious commitment.
- (vi) Counseling of the students should be properly done to allow them see the need to bring up manageable family size which can stem out of population education.

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EFFECTIVENESS OF COMPUTERISED MATHEMATICS GAME-BASED INSTRUCTION ON TIME MANAGEMENT OF STUDENTS WITH MATHEMATICS LEARNING DIFFICULTIES DURING EXAMINATIONS

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Abstract

Time management is very important in everything one engages in. To students, time is very important and it is an indicator of success or failure. In Mathematics, time management on the part of the students is very crucial. More importantly, in the era of technology innovation, time taken to complete a task is vital to academic achievement as instructional contents are adequately timed devoid of manipulation by students. It is on this note that this study explored the efficacy of computer Mathematics game based instruction on time management in examination by students with mathematics learning difficulties. The study employed experimental pre and posttest research design. Three hypotheses were formulated and a total number of 26 participants identified to have shown signs problems of time, space and Mathematics difficulties. The instrument used comprised of computerised Mathematics game based instruction adequately timed, Mathematics interest checklist and Mathematics achievement test with reliability of 0.70 and 0.75 respectively. Both experimental and control groups were pre and post tested. Data were analysed using mean, standard deviation and analysis of covariance. The results revealed significant main effects of treatment on time spent, also there was main effect of gender on time spent but no significant interaction effect between treatment and gender on time spent. Hence, it was recommended that digital based Mathematics game should be employed as pedagogical tool to motivate consciousness of time among students with Mathematics learning difficulties.

Keywords: *Computerised Mathematics game, Time management, Students with Mathematics learning difficulties, Examination.*

Introduction

Mathematics is one of the recognised compulsory subjects at elementary and secondary schools level in Nigeria. It is a subject required by students not minding their intended prospective specialisation before gaining entrance to higher institutions of learning. The importance of Mathematics in all facets of lives has made the subject the centre of every developmental agenda. Mathematics education provides individual with a wide perspective and knowledge to understand the world and enhance their social interaction and their skills (Sayan, 2015). The knowledge and basic skill provide by Mathematics help to analyse various experience, solve problem systematically, facilitate creative thinking and aesthetic development as well as development of reasoning ability and skills of individuals in various situation of life.

In spite of the importance and the dynamic application of Mathematics, there are numbers of factors militating against adequate skills acquisition in the subject. These factors comprised of difficulty in memorizing basic computational and arithmetic symbols, confusion of terminology and symbolic notation system of Mathematics, weak understanding of concepts due to visual-spatial organisation deficit (Garnett, 1998), self-efficacy and motivation (Chun-Ming, Iwen & Gwo-Jen, 2015), gender (Ajai and Imoko, 2014), the role of environment (Suan, 2014) as well as time management in the area of computational accuracy and basic skills in Mathematics within a limited period.

Time management plays a vital role in improving students' academic performance, achievement and task completed within a limit of instructional schedule (Nasrullah & Khan, 2015). The ability to manage time enhance goal achievement in all areas of live. In modern world, time is seen as an indefinitely divisible and usable commodity. The secret of achieving success in life depends on the effective management to time. All events of life happen with time. Time management is measured by available time, allocated time engaged time and pacing which relatively affect value and achievement of tasks. Allocated time is the amount of time assigned for instruction in a content area, without reference to quality of activities being conducted that time (Fisher, Behner, Filby, Mariliave, Cahen, & Disnaw, 1980), available time is the time available for all activities. The available time is limited by the number of days in a school year and number of hours in a school day (Brophy, 1986), engaged time is the amount of time the student is actually involved in such learning task as writing, listening and responding to teacher question (Brophy, 1986) and pacing is the rate at which teachers and students conduct and or engage in a instructional content. This is reflected in the number of second, minutes and hours individual use to complete a work. All these dimensions of time management affect achievement of tasks by students.

Mathematics as a subject involves high cognitive manipulation, effective and efficient understanding of pattern and dimension of computation accuracy as well as time management. The influence that these personal variables such as motivation and ability have on academic success are well documented but there is paucity of research investigating how students maximise time in a carrying out specific activity especially in very sensitive subject like Mathematics by high and low achieving students in the subject.

More importantly, the era of information and communication technology has added new dimension to academic successes and failure. The advancement and popularity of computer and multimedia technologies have encouraged researcher to develop digital contents and system for Mathematics (Chun-Ming, Iwen & Gwo-Jen, 2014). It is one of the recent evolutions in information and communication technologies. Computer game based instruction has been reported to have reduced students Mathematics anxiety, improve self-efficacy, motivation and reasoning (Chun-Ming, Iwen & Gwo-Jen, 2014; Kuo, 2007; Louis and Mistele, 2012; Peter, 2013).

It is imperative that if digital game based instruction could have achieved a lot in influencing affective and cognitive variables, its popularity in the management of time on students' activities and achievement in Mathematics can also be employed. Nasrullah and Khan (2015) noted that time management play a vital role in improving students' academic performance and achievement. Every student no matter the level weakness should have time management ability which includes pacing, setting goal and priority. This is possible through self-motivation, ability and interest (Brigitte, Claessens, Earde & Rutte, 2005). Time management is directly related to the engage in performing a certain task. This is very important in Mathematics as this aids speed and reasoning ability of the students. Therefore, inability to manage time makes students to suffer disadvantage in subject that demand serious time consciousness like Mathematics. Adebayo (2015) noted that time management is as important as human and material resources. This she posited that poor time planners seem to be faced with low achievement, productivity, inefficiency, ineffectiveness, low morale, stress and frustration with themselves. Proper time management becomes important in education especially among students who may believe their achievement is influenced or affected by time taken to complete work. Though Omolara (2010) believed that time is always available but wait for no one and is no respecter of gender as both male and female are affected by time regard achievement.

While various strategies are being employed to improve academic performance or achievement in Mathematics of many individuals with Mathematics difficulty, the issue of time taken or management has not been seriously considered as one of the key factor to success and failure in Mathematics among students. It is therefore imperative to examine time as one of the predictors of academic achievement of some students with Mathematics difficulty. Therefore, this study is on the effect of computer-based Mathematics game on time management examination by some students with Mathematics learning difficulties in Lagos State.

Purpose of the Study

The main purpose of this study is to determine efficacy of computer mathematics game based instruction on time management in examination by students with mathematics learning difficulties. Specifically, the study sought to:

- (i) examine the main effects of treatment on time spent by participants in algebra examination;
- (ii) find out the extent to which the gender of the students would influence the time spent by them in Algebra examination; and
- (iii) examine the interaction effects of treatment and gender on time spent by them in Algebra examination.

Research Hypotheses

Ho₁: There is no significant main effect of treatment on the time spent in Algebra examination by some identified Mathematics learning disabled students.

Ho₂: There is no significant main effect of gender on the time spent in Algebra examination by some identified mathematics learning disable students.

Ho₃: There is no significant interaction effect of treatment and gender on the time spent in Algebra examination by some identified mathematics learning disabled students

Methodology

This study employed pre-test, post-test non-equivalent control group design with experimental and control groups. The population for this study comprised Junior Secondary School 3 (JSS 3) students in Lagos state, Nigeria. The sample for this study comprised selected Junior Secondary School 3 (JSS 3) students in Federal College of Education (Technical) Akoka Staff School and Mighty Oaks Comprehensive high school Iyana Ipaja. A purposive sampling technique was employed by the researchers to select the schools for this study. The schools were selected based on their (i) Accessibility, (ii) Willingness to participate in the study. The schools were situated far apart from each other hence removing the possibility of contamination. The participants were 26 (13 male and 13 female) students with trait of mathematics learning disability as identified after a mathematics interest checklist was administered. Their participation was based on availability and willingness to participate in the study.

The instruments used for this study comprised a purposely designed mathematics game in form of snake and ladder fashioned to teach Algebra, Mathematics Checklist and Mathematics Interest Checklist. The time spent by individual candidates in the Algebra examination was also recorded. The mathematics game was designed by a computer programmer: the game has the following procedure:

- (i) Launch the game on your computer
- (ii) Click on the start button of the game to activate it
- (iii) Click on "role the dies" to display the dies rolled with an algebra problem, the number of the possible outcome of the disc is then substituted for the value expected in the algebra problem.

- (iv) The result then determines the movement of the player on the snake and ladder game. The students were then introduced to how to use the game to solve algebra problems.

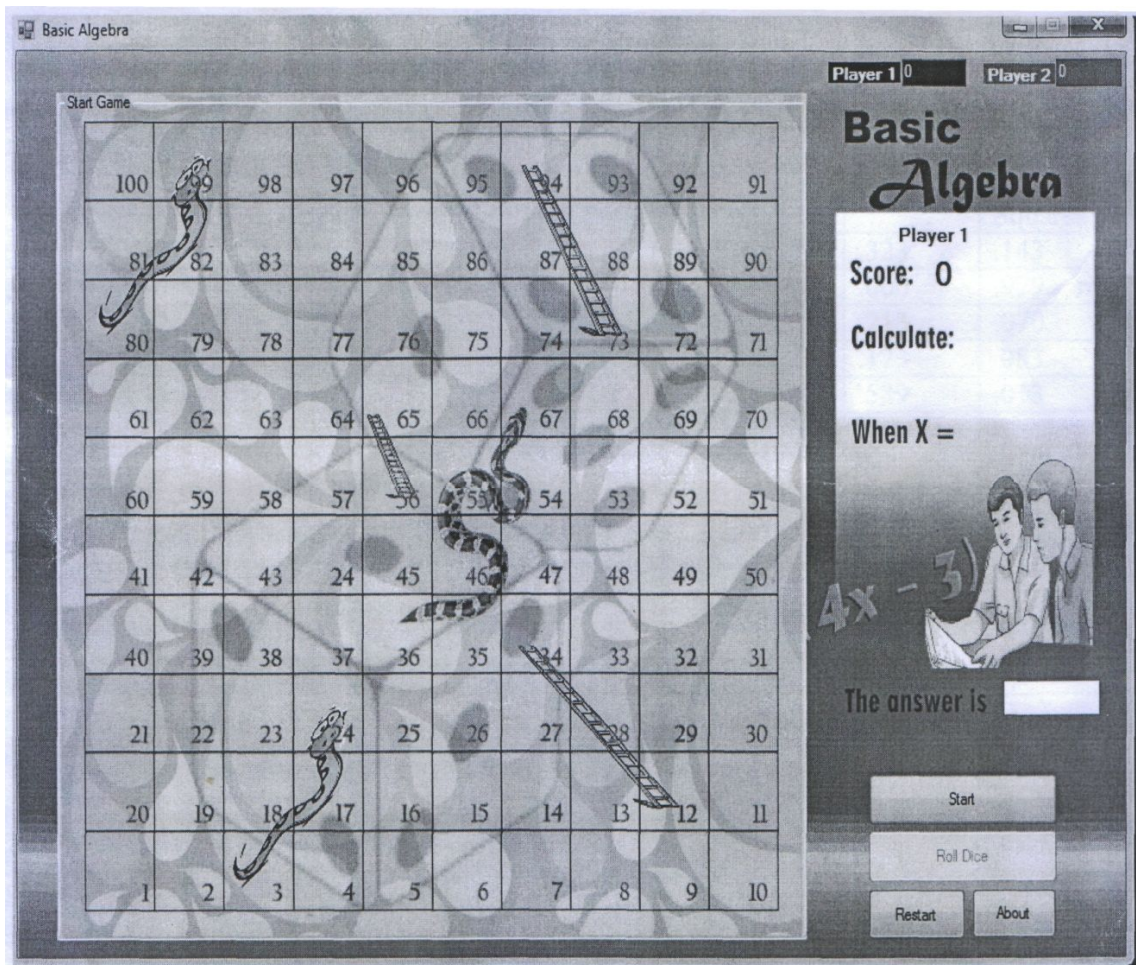


Figure 1: Sampled Comprised Mathematics Game

The Mathematics checklist was adapted from Junior Secondary School examination and validated copies were pilot tested on JS 3 students different from the location of the research. The data generated were subjected to cronbach alpha analysis and reliability coefficient of 0.70 was derived indicating that the instrument was reliable.

Mathematics interest checklist was designed and validated by experts in mathematics and test and measurement. The mathematics interest checklist has norm criterion that made it possible to detect some students who demonstrated trait of Mathematics Learning Difficulties (MLD). Mathematics achievement test adapted from junior secondary school terminal examination with reliability coefficient of 0.91.

The members of the experimental and control groups initially responded to a questionnaire instrument which included a Mathematics checklist. An Algebra test was also administered. During the pretest, the times spent by each of the participants were recorded as PRETIME. Thereafter, the experimental group was taught using algebra computer-based mathematics game while the control group was taught the same concept using the conventional method. Another set of questionnaires and tests were then administered again on the groups after six weeks of treatment. The times spent by each of the students on the tests were also

recorded as POSTTIM. Data collected were analysed using inferential statistics of Analysis of Covariance (ANCOVA) to test the hypotheses at .05 level of significance.

Results

The table below revealed the outcome of the analysis of data collected.

Table 1: Summary of analysis of covariance (ancova) of time spent by students on the post test

Source	Type III sum of squares	Df	Mean Square	F	Sig.	Partial Eta Squares
Corrected model	925.150	3	308.383	29.992	.000	.786
Intercept	33972.246	1	33972.246	2973.501	.000	.993
Treatment	842.400	1	842.400	73.733	.000	.770
Gender	80.865	1	80.865	7.078	.014	.243
Treatment* gender	11.635	1	11.635	1.018	.324	.044
Error	251.350	22	11.425			
Total	39715.000	26				
Corrected Total	1176.500	25				

a. R Squared = .786 (Adjusted R Squared = .757)

Table 2: Scheffe post hoc multiple comparison of time spent

Treatment		Mean difference (I-J)	Std. Error	Sig.
(I) treatment	(J) treatment			
Control	Experimental	11.700*	1.363	.000
Experimental	Control	- 11.700*	1.363	.000

Table 3: Scheffe post hoc multiple comparison of gender

Gender		Mean Difference (I-J)	Std. Error	Sig.
(I) gender	(J) gender			
Male	Female	-3.625*	1.363	.014
Female	Male	3.625*	1.363	.014

Table 4: Summary of mean difference of time spent in the examination by the interaction of treatment and genders

	Gender	N	Post-Time	
			Mean	Standard Error
Control Group	Male	8	41.875	1.195
	Female	8	41.125	1.195
Experimental Group	Male	5	28.800	1.512
	Female	5	33.800	1.512

Hypothesis one states that there is no significant main effect of treatment on the time spent in Algebra examination by some identified Mathematics learning disabled students. The results of table 1 and 2 revealed a significant effect of treatment (mathematics game) on Time Spent in Algebra examination by some identified mathematics learning disabled student ($F(1,25) = 73.733$, $p < 0.05$). Since the p-value of the F ratio is significant, this means that hypothesis one was therefore rejected.

Hypothesis two states that there is no significant main effect of gender on the time spent in Algebra examination by some identified mathematics learning disable students. Tables 1 and 3 revealed that the main effect of gender on Time Spent in Algebra examination by some identified MLD students was statistically significant ($F_{(1,25)} = 7.078$, $p < 0.05$). Hence, hypothesis 2 was therefore rejected.

Hypothesis three states that there is no significant interaction effect of treatment and gender on the time spent in Algebra examination by some identified mathematics learning disabled students. The result from table 1 and 4 revealed that there was no significant interaction between treatment and gender on the time spent in the Algebra examination by some identified mathematics learning disable students. Since ($F_{(1,25)} = 1.018$, $p > 0.05$), hence hypothesis three was therefore accepted. Table 4 showed a higher mean time spent by male participants in the control group, but the trend is different for the experimental group.

Discussion

The study revealed significant effect of treatment (Computer Based Mathematics game) on time spent in Algebra examination by some identified Mathematics learning disabled student. The effect of computer based Mathematics game on time management or time spent in Algebra examination by participants might be attributed to motivation they derived from the digital game mode of instruction. The achievement of this instructional strategy could be seen as a welcome development in learning process of students in general. This development is line with the submission of Alavi, George and Yoo (2002) that said that information technology enhanced learning could be solution for promoting students' Mathematics learning motivation and achievement. The efficacy of computer-based Mathematics game on time management and achievement could be a new development. Time taken in every activities is always very crucial and adequate time management in instructional process is important.

Researches have revealed that most students, including low-achieving students, learn more when their lesson are conducted at a brisk pace because a reasonable fact pace serves to stimulate student attentiveness and participating (Wyne, Stuck, White and Coop, 1986). This is one of what digital based game learning stands to achieve in learning process of students especially students with mathematics learning difficulties.

The study also revealed that there is no significant main effect of gender on the time spent in algebra examination by some identified students with Mathematics learning disabled students. The result revealed main effect of gender on time spent in Algebraic examination by some mathematics learning disabled students. The results is in concordance with Levine, Susan, Huttenlocher, Janellen, Tailor, et al (1999) and Halpern (2000) who all reported that male outperformed their female counterpart in spatial activities/abilities. This can be attributed to innate inherent in males as they usually show great interest in computerised and manipulative activities whereas females demonstrate high dexterity in linguistic related activities. However, the study is contrary to the finding of Ajai and Imoko (2015) who reported no significant difference in the achievement of male and female participants

thereby given indication that male and female students are capable of competing in Mathematics both in mastery and time spent.

The study further revealed that there was no significant interaction between treatment and gender on the time spent in Algebraic examination by some identified Mathematics learning disabled students. This therefore means that there is no treatment implication on gender. The assumption is that the treatment has the same effect on male and female participants as regards time spent in Algebraic examination. This result is in line with the study carried out by Ajai and Imoko (2015) and Ritzhaupt, Higgins and Allred (2011) who reported no significant interaction of treatment and gender among their participants. It can then be concluded that the digital based Mathematics game learning has the effect on the participants not minding their gender affiliation.

Conclusion

Digital game based Mathematics instruction has added a new dimension to pedagogical innovation in the area of achievement, self-efficacy, motivation, interest and confidence among students especially those that demonstrated discrepancy in Mathematics contents mastery. This study was designed to test its effectiveness in improving time spend to achieve a level of mastery among students that show signs of Mathematics learning difficulties. The results have revealed the efficacy of computerised game based learning in improving time spent to solve sums in Algebra with no significant interaction between treatment and gender with implication that all the participants benefitted the same way.

Recommendations

In view of the results above, the following are recommended:

- (i) Digital game based learning should be employed as pedagogical tool to teach Mathematics to students who show evidence partial and time constraints in Mathematics.
- (ii) Gender equality should be encouraged in a very sensitive subject like Mathematics through computer game-based instructions because of its importance both academically and socially.
- (iii) Efforts should be made to make students to be conscious of adequate pacing because the secret of human successes is dependent on effective time management.

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RELATIONSHIP BETWEEN AFFECTIVE CHARACTERISTICS AND STUDENTS' PERFORMANCE IN SCIENCE AND MATHEMATICS IN MAKURDI METROPOLIS OF BENUE STATE

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Abstract

The study was conducted to determine the relationship between affective characteristics of students and their class performance in Science and Mathematics in Makurdi Metropolis of Benue State. The population was made up of Senior Secondary 1 (SS1) science students in Makurdi Metropolis of Benue State. Four hundred and Twenty-one SS1 science students (212 males and 209 females) were randomly selected from 12 schools that offer science subjects and use the government approved report sheets which have provision for assigning values to the affective characteristics of the students. The study was a survey design that collected data on the affective characteristics and class performance of students by using questionnaire. Pearson Product Moment Correlation (PPMC) statistic was used to analysed the data obtained from the affective characteristics scores of the students and their scores in chemistry, physics, biology and mathematics. Two research questions and two hypotheses were used for the study. The findings of the study revealed there was relationship between the affective characteristics scores of male and female science students and their performance in science and mathematics. The study recommends that the teachers should build up good rapport with students to increase attentiveness, class attendance, punctuality and curiosity in the science students.

Keywords: *Affective characteristics, performance, relationship, science, learning*

Introduction

The study of science and mathematics has been recognized all over the world as major tools for advancement of Science, Technology and Mathematics (STM). Science, Technology and Mathematics have become critical factors for sustainable development worldwide. Nations all over the world today are striving hard to develop their students in Science, Technology and Mathematics (STM). Science, Technology and Mathematics have been instrumental in shaping and improving the life of mankind (Nwachuku, 2009). The acquisition of scientific attitudes as well as science process skills necessary for self-reliance and societal adjustment corroborates the fact. STM education also plays an important role in the development of a nation's economy because it forms the basis for the different emerging technologies that the world's operations are now hinged upon. Despite this importance of STM subjects to both individual and national development, students who are supposed to be the link between the knowledge gained in the classroom and societal development still perform below average in external examinations (Akinsowon & Osisanwo, 2014).

Science has multidimensional fields of study. Science, especially at the secondary school level is divided into three major subjects which are chemistry, biology and physics. While chemistry is primarily concerned with matter and its properties, biology deals with the scientific study of living things, their relationship with one another and with the natural environment among other things while physics involves the study of matter, energy and their interactions (Adolphus, Alamina & Aderonmu, 2013).

In their attempt to improve secondary school students' performance in science subjects, researchers over the years have worked on several variables which they tried to manipulate and find out the effects they have on the learning outcomes of students. Despite the numerous teaching strategies put forward by researchers over the years a paradigm shift towards the study of the influence of learners' characteristics on their academic performance also became necessary. Stakeholders in education tend to have overlooked the importance of the affective domain in learning (White, 2014).

While the affective dimensions of science learning have long been recognized as important, they have received much less attention by researchers than have the cognitive dimensions. Reasons for this imbalance include the archetypal image of science itself, where reason is separated from feeling, and the long-standing cognitive tradition of science education research. Often mentioned students' characteristics in research are students' attitude, motivation, perception, conception and manipulative skills which can be classified under affective, cognitive and psychomotor domains. It is the affective characteristics of the learner however, that has received little attention from teachers. The affective characteristics includes a host of constructs, such as attentiveness in the class, attendance to class, punctuality, neatness, politeness, self-control, relationship with others, curiosity, honesty, humility, tolerance, leadership and courage. Less attention has been given to these 13 affective constructs which may encourage or discourage the adoption of effective learning behaviours. Few aspects of affective domain have been demonstrated to have a significant influence on students' learning (McConnell & Kraft, 2011). For example, Perry, Hall and Ruthig (2007) showed a profound link between students' feeling of "control" and learning. Robbins, Lauver, Davis and Langely (2004), Covington (2007), Pekrun (2007), Zusho, Pintrich and Cappola (2003), and McConnell et al. (2010) demonstrated that some aspects of student motivation have more significant influences on college student performance (as measured by class scores) than does student ability measured by standardized test results.

The perception of a task will be strengthened if the students believe that it has relevance to their life and especially after the class hours. A student who places more value and interest in the task typically shows greater learning, persistence, and effort (Wigfield & Eccles, 2002). Students with high values, motivational drive and expectation, will try harder, persist longer on tasks, and generally perform better on course assignments than do students who have lower expectations (Pintrich & DeGroot, 1990; Pintrich, 2003; Bykerk-Kauffman et al., 2009; McConnell et al., 2010). A student who knows what is needed in order to complete a task will begin with low task (or test) anxiety, whereas a student who perceives the task as difficult or is unclear on the expectations may begin with heightened anxiety that can interfere with the learning process.

The influence of gender on affective characteristics of learners especially on attitude, interest and motivation has been a source of concern to most researchers though no consistent result has been established. For instance, results from Awang, Ahmad, Wahad and Mamat (2013) indicated that there are no significant differences between male and female students with regards to most affective items such as attending classes in a timely manner, interest towards teaching aids, enjoyable class activities, being active in class, doing revision and making own note except for items of love to attend everyday class and read additional materials. Also, Akinsowon and Osisanwo (2014) asserted that girls are considerably less interested in science subjects than boys. In contrast, Shekhar and Devi (2012) observed that females have a higher achievement motivation compared to males. It is therefore quite obvious that discrepancies still abound between the affective disposition of males and female's students towards science, and for this reason gender and its effect on

the affective characteristics of the learners in mathematics, chemistry, physics and biology will be considered in this study.

A contemporary view is that the affective dimension is not just a simple catalyst, but a necessary condition for learning to occur (Pintrich, 2003). Attitude and motivation are indeed the most critically important constructs of the affective domain in science education, and remain mostly unmeasured. This assertion therefore provides the impetus for the present study which is aimed at ascertaining the effect of the affective characteristics on the male and female students' test scores in mathematics, chemistry, physics and biology in Makurdi Metropolis of Benue State.

Purpose of the Study

The purposes of the study are:

- (i) to find the relationship between the affective characteristics scores of secondary school students and their performance in mathematics, chemistry, physics and biology.
- (ii) to find out the relationship between the affective characteristics scores of male and female secondary school students and their performance in mathematics, chemistry, physics and biology.

Research Questions

The following research questions were raised to guide the study.

- (i) Is there any relationship between the affective scores of secondary school students and their performance in mathematics, chemistry, physics and biology?
- (ii) Is there any relationship between the affective scores and the performance of male and female science students in mathematics, chemistry, physics and biology?

Hypotheses

The following null hypotheses were formulated to guide the study:

- Ho₁: There is no relationship between the affective scores of secondary school science students and their performance in mathematics, chemistry, physics and biology.
- Ho₂: There is no relationship between the affective scores and the performance of male and female secondary school science students in mathematics, chemistry, physics and biology.

Methodology

The study adopted the survey type of research design. Copies of questionnaire were given to the class teachers at the SSI level for data collection on the affective characteristics of the science students. The population of the study consisted of all SSI science students in Makurdi Metropolis of Benue State. The sample consisted of 421 SSI science students (212 males and 209 females) from 12 schools that offer science subjects and use the government approved report sheets which have provision for assigning values to the affective characteristics of the students. This is because it is those values assigned to the affective characteristics of the students in their report sheets that were correlated with the performance scores of students in each of mathematics, chemistry, physics and biology. The sample for the study was selected through random and purposive sampling techniques across the schools in Makurdi Metropolis of Benue State. The correlation was estimated using the Pearson Product Moment Correlation (PPMC) at 0.05 level of significance.

Instrument

The instrument used for the study consisted of sections A and B. Section A was made up of demographic information of the students on gender, school and class. Section B consisted of 13 general characteristics on the affective development of the science students (tables 2

and 3). The class teacher was to tick (\checkmark) under the headings, excellent (5), very good (4), good (3), fair (2) and poor (1) the one which reflect his opinions most about the students (table 1). This was how the ratings were made on the government report sheet. The class performance of each science and mathematics students was also collected.

Table 1: Key to rating the students' affective characteristics

Heading	Excellent	Very Good	Good	Fair	Poor
Point	5	4	3	2	1

Decision

The strength of the relationship was tested using the following statistical decision of coefficient of correlation at $p = 0.05$ (Daramola, 2006).

If $0.0 \leq r \leq 0.20$, relationship is negligible

If $0.21 \leq r \leq 0.40$, relationship is low

If $0.41 \leq r \leq 0.60$, relationship is moderate

If $0.61 \leq r \leq 0.80$, relationship is substantial

If $0.81 \leq r \leq 1.00$, relationship is high

Data Analyses

The points in table 1 was used to score the ratings of the teachers to the items of the questionnaire. Hypotheses 1 and 2 were tested after calculating using Pearson Product Moment Correlation at 0.05 level of significance. SPSS version 21 was used for the analyses.

Results

The result of the study is presented below based on the hypotheses of the study.

Ho₁: There is no relationship between the affective scores of secondary school science students and their performance in mathematics, chemistry, physics and biology.

Table 2: Correlation coefficients of science students' affective characteristics scores and performance in Mathematics, Chemistry, Physics and Biology

Affective Char	Correlation r for Students Scores			
	Maths	Chem	Phys	Bio
Attentiveness	.68	.54	.56	.50
Attendance	.67	.46	.40	.35
Punctuality	.53	.60	.57	.55
Neatness	.47	.42	.35	.71
Politeness	.42	.50	.26	.62
Self control	.76	.52	.51	.50
Relationship with others	.64	.56	.47	.50
Curiosity	.65	.40	.52	.63
Honesty	.29	.26	.48	.56
Humility	.48	.54	.38	.54
Tolerance	.45	.46	.59	.50
Leadership	.42	.49	.50	.60
Courage	.08	.18	.08	.17

Table 2 shows the correlation coefficients between students' affective score and their performance in mathematics, chemistry, physics and biology. The correlation coefficients between attentiveness and score in mathematics ($r = .68$) showed a substantial relationship. Substantial relationship was also obtained between students' scores in attendance and score

in mathematics (.67), self-control and score in mathematics (.76), students neatness and score in biology (.71) among others. The least correlation coefficients are between students scores in courage and mathematics ($r = .08$), chemistry ($r = .18$), physics ($r = .08$) and biology ($r = .17$) which all gave negligible relationships.

Ho₂: There is no relationship between the affective scores and the performance of male and female science students in mathematics, chemistry, physics and biology.

Table 3: Correlation coefficients of male and female students' affective scores and performance in Mathematics, Chemistry, Physics and Biology

Affective Characteristics	r for Male Students Scores in				r for Female Students Scores in			
	Maths	Chem	Phys	Bio	Maths	Chem	Phys	Bio
Attentiveness	.78	.48	.53	.47	.55	.52	.56	.59
Attendance	.67	.32	.38	.34	.62	.61	.42	.42
Punctuality	.45	.58	.67	.33	.57	.74	.92	.53
Neatness	.43	.33	.25	.56	.56	.61	.52	.86
Politeness	.34	.47	.25	.65	.55	.52	.31	.59
Self-control	.56	.43	.45	.37	.92	.61	.58	.62
Relationship with others	.67	.47	.38	.45	.57	.54	.62	.63
Curiosity	.54	.41	.46	.47	.56	.39	.59	.79
Honesty	.37	.24	.50	.56	.25	.52	.46	.59
Humility	.43	.30	.40	.54	.52	.61	.35	.62
Tolerance	.34	.54	.56	.37	.57	.54	.62	.63
Leadership	.28	.48	.39	.53	.56	.59	.59	.68
Courage	.06	.21	.03	.21	.10	.19	.13	.13

Table 3 shows the correlation coefficients of male and female students' affective scores and their performances in mathematics, chemistry, physics and biology. The highest correlation coefficient of $r = .86$ was obtained between female science students' scores in punctuality and physics, and showed substantial relationship. For the male students, the correlation between affective score of students in attentiveness and scores in mathematics, $r = .78$ also showed a substantial relationship. Negligible relationships were obtained between scores of male and female students in courage and mathematics, chemistry, physics and biology.

Discussion and Conclusion

The findings of this study can be obtained from tables 2 and 3. Table 2 shows relationship between students' affective scores and performance in Mathematics, Chemistry, Physics and Biology. The correlation coefficients between attentiveness and score in mathematics ($r = .68$) showed a substantial relationship. Substantial relationship was also obtained between attendance and score in mathematics (.67), self-control and score in mathematics (.76), students' neatness and score in biology (.71) among other showed substantial relationship. These showed that the affective characteristics terms of attentiveness, class attendance, punctuality, relationship with others and curiosity among others play important roles in the performance of the students. These agree with the findings of Michelli (2013) that found significantly positive correlation between students' attitudes and their performance in Mathematics. Also Olusola and Rotimi (2012) found out that students do well in physics when they adopt a positive attitude to the subject. On a general basis, Narmadha and Chamundeswari (2013) found out in their study that positive disposition of students at the secondary school level towards the learning of science leads to a subsequent improvement in their academic achievement.

Data in table 3 show the correlation coefficients between male and female students' affective scores and their performances in mathematics, chemistry, physics and biology. The correlation coefficient between male science students' scores in attentiveness and mathematics was the highest ($r = .78$) and showed a substantial relationship. The relationship between female students scores in punctuality and physics ($r = .92$) also showed a substantial relationship. These findings corroborated that of Fatoba and Aladejana (2014) in a study in which they examined the effects of gender on secondary school students' attitude in Physics. There was slight difference in attitude of the students in favour of females which led to better performance. In another related study, Adebule and Aborisade (2014) observed no significant difference in gender and the correlation between affective characteristics and performance of secondary school students in Mathematics and therefore recommended that sex should not be considered as a factor influencing the affective characteristics of students towards Mathematics and thus teachers should teach the subject freely among students of different genders. Oluwatelure (2015) revealed that there was a significant gender difference in the performance of students in science. A significant difference was also observed in the attitude of male and female students. A positive relationship was observed in the attitude and performance of students in science. A positive relationship was also observed between students' attitude towards science and scientific attitudes of the respondents. Conclusively, gender of learners is an important factor that must be considered in the teaching and learning of science. Both male and female developmental inputs are required for the development of science and technology in the society.

Recommendations

From the findings, the following recommendations were made.

- (i) Students should be exposed to a friendly and interesting classroom environment. Comfortable learning environment will create a good positive attitude and discourage bad attitudes. As students' achievements are associated with their attitudes, values, interest, motivation and participation in class activities, organizing learning environment in an attractive manner is vital.
- (ii) There should be change in learning attitude from boredom, sheer drudgery, apathy and indifference to enthusiasm and excitement, to allow students develop appropriate affective characteristics.
- (iii) The current study also recommends that the teachers should build up good rapport with students to increase attentiveness, class attendance, punctuality and curiosity in the science students.
- (iv) There is a pressing need to look more closely at the nature of the teaching and learning processes in classes and to note the affective factors that contribute to consistent improvements to students' performance.

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EXAMINING LECTURERS' AND STUDENTS' ACCEPTANCE OF COMPUTER-BASED TEST IN SELECTED NIGERIAN UNIVERSITIES

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Abstract

Computer-Based Testing (CBT) is a mode of administering test in which the responses are electronically recorded, assessed, or both but universities in Nigeria are using CBT with paper-based test for academic assessment of students depending on students' population and lecturers interest which shows partial acceptance. This study examined the predictors of lecturers' and students' acceptance of CBT as a method of administering tests in selected Nigerian Universities. The study is a descriptive research type using cross sectional survey. The sample for this study comprises 420 lecturers and 806 undergraduates from four selected Nigerian universities. Data was collected through a researcher designed questionnaire for lecturers and students' acceptance of CBT. The internal consistency of the instrument was determined using Cronbach Alpha for 0.72 and 0.78 coefficient for lecturers and students instrument. Multiple regression was used to determine the relationship among the variables of perception (Perceived Usefulness (PU), Perceived Ease of Use (PEOU) and Perceived Credibility (PC)) and acceptance of CBT. The result shows that the most significant variable was Perceived Ease of Use for lecturers' and Perceived Usefulness for students'. Based on these findings, it was concluded that relationship between their perception and acceptance was significant. It was recommended that Nigerian Universities should intensify efforts in improving on their CBT centres and make provision for necessary facilities for the conduct of the exams so that students can have their examinations easily without any delay.

Keywords: *Information and Communication Technology, Computer-Based Test, Technology Acceptance Model, Learning Assessment, E-testing*

Introduction

Information and Communication Technology (ICT) involves the application of new technologies in an educational context and environment, and also a tool for supporting various components of education such as teaching and learning, resources management (human, material, financial resources) and admission and examination processes also known as learning assessment (Joshua, Joshua & Ikiroma, 2016). One specific form of ICT for assessment is the Computer-Based Test (CBT), also known as Computer-Based Assessment or e- assessment/testing. CBT simply refers to tests and assessments conducted through the use of the organized systems on computers with the ability to automate a very time consuming task, marking and monitoring progress (Olumorin, Fakomogbon, Fasasi, Olawale & Olafare, 2013). It is a method of administering tests in which the responses are electronically recorded, assessed, or both.

Olafare (2014) stated that CBT involves a range of activities which include the delivery, marking, and analysis of all or part of the student assessment process using computer technologies alone. CBT also increases the frequency of assessment, motivates students to learn and encourages skill practice, to broaden the range of knowledge to be assessed by lecturers. CBT increases feedback to students and lecturers involved, increases objectivity, consistency and reduction in marking loads of script and other cases resulting in administrative efficiency and credibility.

CBT for internal examinations in Nigerian Universities are conducted in CBT centers higher institutions which may be managed by the institutions or corporate body using a PC with an Internet connection and an online proctoring service. Although this transitions through CBT has healed the setback been faced by the traditional paper-pencil system which has been long associated with inconsistency, fraud, poor delivery, malpractice, insecurity, improper scoring of candidates and so on in Nigerian Universities (Ipaye, 2009, Ogunlade & Olafare, 2015) but these universities are still using CBT with paper-based test for students assessment depending on students population, nature of the course and lecturers interest which shows partial acceptance.

For Nigerian universities to transit from the paper-based test (PBT) to CBT for academic assessment of students like other universities globally, lecturers and students must accept the usage based on its usefulness, ease of use and credibility which are the major factors affecting the transition. According to Jones (2000) the successes of transition from PBT depend on the extent and ability of stakeholders such as lecturers and students to accept the benefits and limitations of mode of assessment because the face of examinations in Nigeria is gradually getting a new look due to the introduction of the computer-based test (CBT) system by examination bodies like Joint Admission Matriculation Board (JAMB) transiting totally from PBT to CBT in conducting their Unified Tertiary Matriculation Examination (UTME) for prospective students to higher education. JAMB in their website defined Computer-based testing as a simple and better way to offer the Jamb test as it allows testing centers to offer a more consistent test delivery, faster scoring and reporting, and enhanced test security.

The rationale for the development and integration of educational technologies in Nigerian University was to fast track two priority areas in the Universities strategic plan, they are: Expanding access and participation and enriching quality academic programmes through the infusion of ICT such Computer Based Test (Olumorin et.al.2013). For the transition from PBT to CBT as a mode of assessment in Nigerian Universities, the executive management of the institutions must commit resources for the development and improvement of the assessment mode (Olawale & Shafi'i, 2010). The acceptance of computer-based test as a mode of assessment depend on perception of the stakeholders (Olafare, 2014) in terms of how useful the technology is, how easy is it to use and how reliable and credible it is for assessment. On this note, Technology Acceptance Model (TAM) was introduced to determine lecturers and students acceptance of CBT.

Studies on the user's perception and acceptance of CBT focused on them separately as reasons for use of CBT but did not specifically make use of a standard model like Technology Acceptance Model (TAM) and also nothing has been doing on their relationship (Olafare, 2014). However, Technology Acceptance Model (TAM) is which is more on perception is one of the successful approaches that leads to acceptance of technology. According to Venkatesh (2000), TAM has a predictive power that makes it easy to apply to different situations. Though TAM has been extensively tested and validated among users of technology but research on its application in the field of education is limited because it dwells more on perception. In the application of Technology Acceptance Model developed by Davis (1989), the constructs identified by TAM and the additional one by the researcher for this study are perceived usefulness, ease of use, credibility.

Researchers had use Technology Acceptance Model (TAM) to measure the perception of stakeholders on the of CBT (e.g Nurcan 2010, Terzis & Economides 2011, Olafare, 2014) but the researchers in their studies did examine the level of acceptance based on the relationship of the variables that determine the acceptance of computer-based test for

assessment in Nigerian Universities. This is an indication that studies examining the relationship between perception and acceptance of computer-based test in Nigerian university context seem to have been ignored. It is on this note that this study examined the relationship between lecturers' and students' perception and acceptance of computer-based test in selected Nigerian universities based on:

- (i) the relationships among the variables of lecturers perception (perceived usefulness, perceived ease of use and perceived credibility) and acceptance of CBT in selected Nigerian universities.
- (ii) the relationships among the variables of students perception (perceived usefulness, perceived ease of use and perceived credibility) and acceptance of CBT in selected Nigerian universities.

Research Hypotheses

Ho₁: There is no significant relationship among the variables of lecturers' perception (perceived usefulness, perceived ease of use and perceived credibility) and acceptance of CBT in selected Nigerian universities.

Ho₂: There is no significant relationship among the variables of students' perception (perceived usefulness, perceived ease of use and perceived credibility) and acceptance of CBT in selected Nigerian universities.

Methodology

This study is a correlation research design. The study was limited to lecturers' and students' perceptions and acceptance of computer-based tests in Nigerian universities by determining their perception (perceived usefulness, perceived ease of use and perceived credibility) and level of acceptance of computer-based test in Nigerian Universities. The target population for this study consists of 420 lecturers and 806 students in the two purposively selected Universities in North central Nigeria (University of Ilorin, Ilorin and Kogi State University, Anyigba) that have been using Computer-based test in their Universities for assessment for over 8 years. This gives a total of 1226 respondents for the study. Simple random sampling was used to select sample from the lecturers and students population in the selected universities. The sample size for this study was determined from the total number of lecturers and students who were users of computer-based test in the selected Nigerian universities during the 2015/2016 academic session. Table 1 and 2 below shows the total number of lecturers and students from the selected universities.

Table 1: Lecturers sample election

Universities	Total number of students	Sample
University of Ilorin	2,205	297
Kogi State, University	910	123
Total	3,115	420

Table 2: Students Sample Selection

Universities	Total number of students	Sample
University of Ilorin	37,222	481
Kogi State, University	17,547	325
Total	54,769	806

A researcher-designed questionnaire on Lecturers' and Students' Perceptions and Level of Acceptance of Computer-based Test in Nigerian Universities was used for the collection of data in this study. The instrument was designed to reflect the lecturers' and students' perceived usefulness, perceived ease of use, perceived credibility and acceptance of computer-based test.

Results

Ho₁: There is no significant relationship among the variables of lecturers' perception (perceived usefulness, perceived ease of use and perceived credibility) and acceptance of CBT in selected Nigerian universities.

In order to test hypotheses 1, responses of the lecturers to each of the segments (perceived usefulness, perceived ease of use and perceived credibility) in the perception inventory were collated separately on statistical coding sheets. The lecturers' response for the level of acceptance were also collected and recorded in another coding sheet. The segments (variables) in perception inventory were used as independent variables while the data on level of acceptance was used as the dependent variable. The two sets of data (independent and dependent) were subjected to Multiple Regression analysis and the output revealed thus:

Table 3: The relationship among independent variables and dependent variable

Model	Sum of Squares	df	Mean Square	F-value	p-value
Regression	1902.098	2	237.76		
Residual	15207.448	417	52.26	2.15	0.02
Rejected					
Total	12109.547	419			

Critical Level of Sig. = 0.05

Table 3 shows that the calculated F-value is 2.15 and the Sig-value is 0.02 with 2 and 417 degrees of freedom (df) computed at 0.05 level of significance. Since the sig value 0.02 is lesser than 0.05, hypothesis 1 is hereby rejected. This implies that there is a significant relationship among the variables of lecturers' perception (perceived usefulness, perceived ease of use and perceived credibility) and acceptance of CBT in selected Nigerian universities.

To ascertain the contribution of the independent variables together, R-Square was then computed as shown in the table below.

Table 4: Model summary showing contribution of independent variables together

Model R	R-Square	Adjusted R-Square	Std Error of Estimate
1	.313	.111	.087
			7.22906

Table 4 shows that all independent variables together contributed to R-square of .111 (11.1%) to the model (acceptance). This implies that several other factors could influence the acceptance of CBT. In order to ascertain the contributions of each of the independent variables to acceptance of CBT, Beta weight was computed and the output is shown below.

Table 5: Contributions of the independent variables to acceptance of CBT

Study habits	Unstandardized		Standardized			
	Ranks					
		Coefficients	Coefficients			
	B	Std. Error	Beta	t	p-value	
(Constant)	33.23	17.88		4.22	.000	
PU	409	.203	.134	2.02	.004	2 nd
PEOU	644	.207	.287	3.12	.002	1 st

Table 5 indicates that perceived ease of use ranked first by contributing the highest Beta weight of 0.287 and perceived usefulness ranked second as it contributed 0.137. Thus it could be inferred from the findings of the study that the relationship that exists between lecturers' perception and level of acceptance of CBT is predictable across the variables of perception.

HO₂: There is no significant relationship among the variables of students' perception (perceived usefulness, perceived ease of use and perceived credibility) and acceptance of CBT in selected Nigerian universities.

In order to test hypotheses 2, responses of the students to each of the segments (perceived usefulness, perceived ease of use and perceived credibility) in the perception inventory were collated separately on statistical coding sheets. The students' response for the level of acceptance were also collected and recorded in another coding sheet. The segments (variables) in perception inventory were used as independent variables while the data on level of acceptance was used as the dependent variable. The two sets of data (independent and dependent) were subjected to Multiple Regression analysis and the output revealed thus:

Table 6: The relationship among independent variables and dependent variable

Model	Sum of Squares	df	Mean Square	F-value	p-value
Regression	902.018	2	237.76		
Residual	13207.418	803	52.26	3.52	0.01
Total	10109.517	805			

Critical Level of Sig. = 0.05

Table 4 shows that the calculated F-value is 3.52 and the Sig-value is 0.01 with 2 and 803 degrees of freedom (df) computed at 0.05 level of significance. Since the sig value 0.01 is lesser than 0.05, hypothesis 2 is hereby rejected. This implies that there is a significant relationship among the variables of students' perception (perceived usefulness, perceived ease of use and perceived credibility) and acceptance of CBT in selected Nigerian universities.

To ascertain the contribution of the independent variables together, R-Square was then computed as shown in Table 7.

Table 7: Model Summary Showing Contribution of Independent Variables together

Model	R	R-Square	Adjusted R-Square	Std Error of Estimate
1	.412	.117	.072	6.12105

Table 7 shows that all independent variables together contributed to R-square of .117 (11.7%) to the model (acceptance). This implies that several other factors could influence the acceptance of CBT. In order to ascertain the contributions of each of the independent variables to acceptance of CBT, Beta weight was computed and the output is shown below.

Table 8: Contributions of the independent variables to acceptance of CBT

Study habits	Unstandardized		Standardized			
	Ranks					
	Coefficients		Coefficients			
	B	Std. Error	Beta	t-value	p-value	
(Constant)	42.21	19.21		4.12	.000	
PU	519	.303	.334	2.31	.001	1 st
PEOU	324	.204	.217	3.02	.003	2 nd

Table 5 indicates that perceived usefulness ranked first by contributing the highest Beta weight of 0.334 and perceived ease of use ranked second as it contributed 0.217. Thus it could be inferred from the findings of the study that the relationship that exists between students' perception and acceptance of CBT is predictable across the variables of perception.

Discussion

This finding is consistent with some other findings reported in the literature such the report by Linn and Miller (2005) who reported that computer-based test is easy to use as it is not stressful. Similarly, Ricketts and Wilks (2002) also reported that computer-based test is perceived to be easy to use as it is user friendly and the user friendliness aids its usefulness. Farrell and Leung (2004) reported that the competency level of lecturers increases the rate at which they find CBT easy to use. In the same vein, the report by Venkatesh (2000) shows the inter-relationship between usefulness and ease of use of computer-based test produced substantial support for its acceptance.

Conclusion

This study explored the relationship among the variables of lecturers' and students' perception (perceived usefulness, ease of use and credibility) of computer-based test in Nigerian Universities. This study inferred that since the relationship between their perception and acceptance was significant. However, all the variables of perceptions contributed only 11.1% and 11.7% for both lecturers and students which indicated that some other factors could have played significant roles in the dwindling of the transition of PBT to CBT in Nigerian Universities.

Recommendation

In the light of the findings and conclusions made in this study, it is recommended that conscious efforts should be made by stakeholders – school management and Ministries of Education(s) to help encourage lecturers and students to imbibe effective use of CBT. Nigerian Universities should intensify efforts in improving on their CBT centres and make

provision for necessary facilities for the conduct of the exams so that students can have their examinations easily without any delay.

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EFFECT OF MULTIMEDIA INSTRUCTIONAL APPROACH ON ACHIEVEMENT OF
AUTO-MECHANICS STUDENTS IN SCIENCE & TECHNICAL
COLLEGES IN BENUE STATE, NIGERIA

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Abstract

The purpose of the study was to determine the Effect of Multimedia Instructional Approach on Achievement of Auto-mechanics Students in Science and Technical Colleges in Benue State, Nigeria. Three research questions and hypotheses guided the study. The pre-test-post-test non-equivalent control group quasi-experimental design was adopted. The population of the study comprised of 150 Part 1 (SSS 1) students in the auto-mechanics trade. Auto-Mechanics Achievement Test (AMAT) was used for data collection, and analyses were made using the mean, while ANCOVA was used to test null hypotheses at 0.05 level of significance. The study found that; those taught with multimedia instructional approach had higher mean achievement scores in the AMAT than their counterparts taught without multimedia, and no significant difference exists between the post-test mean achievement scores of students with respect to ability-level and gender. It was recommended among others that multimedia instructional approach should to be integrated in the teaching of auto-mechanics trade.

Keywords: *Multimedia, Achievement, Ability-level, Gender*

Introduction

Technical education is a skilled oriented training which facilitates the acquisition of practical and applied skills as well as basic scientific knowledge in a specific trade. Rhodes, (1999) saw technical education as the form of Education that gives a definite purpose and meaning to education by relating education to occupational goals, providing technical skills necessary for employment, developing abilities, attitudes, work habits and appreciation which contributes to a productive life. Prior to colonialism, technical skills were acquired through apprenticeship to serve the technological needs of local communities. As times went on, technical education was gradually developed as a means to responding to the sophisticated technological and industrial demands of Nigeria. Since then, it has received the backing of the National Policy on Education (NPE) in all series.

In the present dispensation, technical education is offered in science and technical colleges. The science and technical colleges are meant to produce skilled craftsmen/women for various industrial technical sectors. They offer various trades such as wood work, block laying and concreting, welding and fabrication, including auto-mechanics. Generally, auto-mechanics trade offers skills leading to the production of craftsmen/women, technicians, and other skilled personnel who will be enterprising and self-reliant [National Board for Technical Education (NBTE), 2001].

However, the quality of auto-mechanics craftsmen from science and technical colleges remains low. Unongo, (2008) laments that auto-mechanics graduates are neither employable nor possess the entry requirements for higher education. Supposedly, Ames

(1998) traced the menace to lack of interest on the part of learners, and uninteresting teaching strategies used by teachers.

Suffice it to say that, there is at least one generation gap between the "Learners and the Teachers". It is also important to recognize that the 21st century learners are indeed very different from what we were as students. They are born during the computer age, and are more fascinated by what appears on the screen than what appears on the paper. To this effect, Mayer, Fennell, Farmer, and Campbell (2004) noted that science and technology needs an integration of information and communication technology (ICT) into learning, teaching and assessment, as a means of providing a better education in science and technology. Federal Republic of Nigeria (FRN), (2004) considers ICT as divers set of technological tools and resources used to create, communicate, disseminate, store and manage information in electronic form. ICT can be used in education to create learning environments such as computer based laboratories, simulations, intelligent tutors, and multimedia.

Multimedia is a computer learning package which incorporates any three of text, audio, graphics and animation. According to Ryan, (2011) multimedia has the potential and functionality to enhance achievement and retention of knowledge compared to lecture method. It is proposed therefore that multimedia instructional approach would influence interest and achievement of auto-mechanics students with visual, auditory, or kinaesthetic learning styles. Supposedly, Moreno and Mayer (2000) expressed that people learn through the five senses and the contribution of each to the amount of what is learnt varies. Moreno and Mayer estimated that out of 100%; 1% is learnt through taste, 1.5% through touch, 3.5 through smell, 11% through hearing, and 83% through seeing. Putting hearing and seeing together indicates that 94% of learning can be achieved with multimedia instructional approach.

Achievement refers to intellectual and skills attained by a student in a particular subject, measured by a score obtained in a test. Achievement can be influenced by several factors including; teaching method, students' background, intelligence, interest, environment and motivation (Ryan, 2011). In a related development, a study carried out by Lowman (2006) to articulate the characteristics of good teaching and how it influences students' academic achievement found that, teaching method and teaching aids used by a teacher to present knowledge have significant influence on students' achievement irrespective of ability-level and gender. While ability level is the intellectual and skills differences that exist in between students subjected to a particular discipline, gender is the physical and behavioural difference that distinguishes individuals according to their functions in the reproductive process (Redmond, 2009). Generally, on ability-level, students are classified as low-ability level students and high-ability level students. The low-ability level students are those who obtain $\leq 50\%$ in a given test, while the high-ability level students are those who obtain $> 50\%$ in a given test (Akem, 2006). While on gender, students are classified as male and female. It is therefore imperative to investigate if the use of multimedia instructional approach can enhance achievement of auto-mechanics students in science and technical colleges, irrespective of ability-level and gender.

Statement of the Problem

Poor performance of students in auto-mechanics trade as evident in the National Technical Certificate (NTC) examination has assumed a pathetic dimension. The National Business and Technical Examinations Board (NABTEB) (2011), (2012) Chief Examiners' Report, and results analyses by principals of science and technical colleges in Benue State has consistently indicated that, auto-mechanics students are persistently recording $< 50\%$ achievement. The

consequences of persistent poor achievement of auto-mechanics students are but not limited to; low academic advancement status, low productivity, unemployment, low income, and low quality of living, slow pace in national development. These critical points present a problem that requires attention. Since it is not clear whether auto-mechanics students in science and technical colleges in Benue State are usually taught with multimedia instructional approach, it is imperative to investigate if multimedia instructional approach would influence better achievement of students in auto-mechanics trade.

Purpose of the Study

The purpose of the study is to investigate the effect of multimedia instructional approach on achievement of auto-mechanics students in science and technical colleges in Benue State, Nigeria. Specifically, the study sought to:

- (i) Determine the mean achievement score of students exposed to multimedia instructional approach with their counterparts exposed to lecture method.
- (ii) Compare the mean achievement score of low-ability level students with high-ability level students exposed to multimedia instructional approach.
- (iii) Determine the influence of gender on academic achievement of auto-mechanics students when taught with multimedia instructional approach.

Research Questions

- (i) What are the mean achievement scores of students exposed to multimedia instructional approach over their counterparts exposed to lecture method?
- (ii) What is the mean achievement score of low-ability level students compared with high-ability level students exposed to multimedia instructional approach?
- (iii) What is the influence of gender on academic achievement of auto-mechanics students when taught with multimedia instructional approach?

Research Hypotheses

- (i) There is no significant difference between the mean achievement score of students exposed to multimedia instructional approach and their counterparts exposed to lecture method.
- (ii) There is no significant difference between the mean achievement score of low-ability level students and high-ability level students exposed to multimedia instructional approach.
- (iii) There is no significant difference between the mean achievement score of male and female students exposed to multimedia instructional approach.

Research Methods

The study adopted the Quasi-experimental design. Specifically, the pre-test-post-test non-equivalent control group design was used. The study was conducted in Benue State where 150 (been the sum total of Part One students, equivalent to Senior Secondary School 1), were recruited into the study from five science and technical colleges that offer auto-mechanics trade. No sample was taken, in order to obtain a more justifiable result. Hence the population of the study constituted the sample. A twenty item multiple choice Auto-Mechanics Achievement Test (AMAT) was administered on the control, and experimental groups. All the items were drawn from the past questions on Engine Maintenance and Refurbishing in the NTC Examination conducted by NABTEB Nigeria, from 2006 to 2012. A pre-test was conducted to ascertain the intelligence status of the groups. Those who scored $\leq 50\%$ and those who scored $> 50\%$ were classified as low-ability, and high-ability level students respectively. Thereafter, the experimental groups were taught using the Auto-mechanics Multimedia Package (AMP) while the control groups were taught using the lecture method. Finally, a post-test was administered on the control, and experimental groups and

the scores of both groups in pre-test and post-test were recorded and compared. The research questions were answered using the mean of the test scores, while Analysis of Covariance (ANCOVA) was used to test the null hypotheses at 0.05 level of significance, using the Statistical Package for Social Sciences (SPSS). Where the P- value was greater than the 0.05 level of significance (P- value > 0.05 level of significance), the null hypothesis was therefore accepted. But where reverse was the case (P- value < 0.05 level of significance); the null hypothesis was rejected.

Results

Table 1: Mean for pre-test and post-test auto-mechanics achievement test (AMAT) scores for the control and experimental groups

Group	Descriptive Statistics	
	N	Mean
Control Group Pre-Test	79	9.3600
Experimental Group Pre-Test	71	9.4933
Control Group Post-Test	79	10.8800
Experimental Group Post-Test	71	17.6533
Valid N (listwise)	75	

The result presented in Table 1 above shows that the control group and the experimental group had the pre-test mean scores of 9.36 and 9.49 respectively. The difference in the pre-test is negligible. However, the post-test mean scores for the control group and the experimental group were 10.88 and 17.65 respectively. The difference in their mean post-test score of 6.77 indicated that, the experimental group recorded higher achievement than their control group counterparts in Auto-Mechanics Achievement Test (AMAT).

Table 2: Mean achievement scores of low-ability level students and high-ability level students taught using multimedia instructional approach

Ability Level	Descriptive Statistics	
	N	Mean
Low Ability Level Students	25	17.6667
High Ability Level Students	46	17.6458
Valid N (listwise)	25	

The result presented in Table 2 shows that 71 students comprising of 25 low-ability and 46 high-ability level students were taught using multimedia instructional approach in which, the low-ability level students had mean achievement score of 17.67 while the high-ability level students had mean achievement score of 17.65. The difference in their mean achievement score of 0.02 is not statistically significant hence indicating that both the low-ability level students and the high-ability level students performed equally when taught using multimedia instructional approach.

Table 3: Mean Achievement Scores of Male and Female students taught using Multimedia Instructional Approach

Gender	Descriptive Statistics	
	N	Mean
Male	50	17.5686
Female	23	17.8333
Valid N (listwise)	23	

The result presented in Table 3 above shows that 71 students comprising of 50 male and 23 female, were taught using multimedia instructional approach in which, the male students had mean achievement score of 17.57 while the female students had mean achievement score of 17.83. The difference in their mean achievement score of 0.26 is not statistically significant hence indicating that both the male and female students performed equally when taught using multimedia instructional approach.

Hypothesis 1: There is no significant difference between the mean achievement score of students exposed to multimedia instructional approach and their counterparts exposed to lecture method.

Table 4: ANCOVA Test of between the experimental group and the control group mean achievement scores

Source	Type III Sum of Squares	df	Mean Square	F-value	p-value
Corrected Model	.409 ^a	1	.409	.112	.739
Intercept	770.500	1	770.500	210.763	.000
CGPT	.409	1	.409	.112	.739
Error	266.871	73	3.656		
Total	20341.000	75			
Corrected Total	267.280	74			

From Table 4; the Sig. P-value of $0.00 < 0.05$. It indicates that there is significant difference, thus rejecting the null hypothesis one (H_{01}). This implies that there is significant difference in the post-test mean achievement score of auto-mechanics students in science and technical colleges exposed to multimedia instructional approach and their counterparts exposed to lecture method.

Hypothesis 2: There is no significant difference between the mean achievement score of low-ability level students and high-ability level students exposed to multimedia instructional approach.

Table 5: ANCOVA Test of between the mean achievement scores of low-ability level students and high-ability level students exposed to multimedia instructional approach

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	6.804 ^a	1	6.804	1.907	.180
Intercept	10.368	1	10.368	2.906	.101
High Ability-Level Students	6.804	1	6.804	1.907	.180
Error	89.196	25	3.568		
Total	8523.000	27			
Corrected Total	96.000	26			

From Table 5; the Sig. P-value of $0.10 > 0.05$. It indicates that there is no significant difference, thus accepting the null hypothesis two (H_{02}). This implies that there is no significant difference in the post-test mean achievement score of low-ability level students and high-ability level students of auto-mechanics in science and technical colleges exposed to multimedia instructional approach.

Hypothesis 3: There is no significant difference between the mean achievement score of male and female students exposed to multimedia instructional approach.

Table 6: ANCOVA Test of between the mean achievement scores of male and female students exposed to multimedia instructional approach

Source	Type III Sum of Squares	df	Mean Square	F	p-value
Corrected Model	9.366 ^a	1	9.366	3.878	.062
Intercept	5.225	1	5.225	2.163	.155
Female	9.366	1	9.366	3.878	.062
Error	53.134	22	2.415		
Total	8056.000	24			
Corrected Total	62.500	23			

From Table 6; the Sig. P-value of $0.16 > 0.05$. It indicates that there is no significant difference, thus accepting the null hypothesis three (H_{03}). This implies that there is no significant difference in the post-test mean achievement score of male and female students of auto-mechanics in science and technical colleges exposed to multimedia instructional approach.

Discussion

The results presented in Table 1 indicated that there was no difference between the mean pre-test scores of both control and experimental groups. However, their post-test mean achievement scores showed that the experimental group and the control group obtained mean scores of 17.65 and 10.88 respectively. The difference in their mean post-test score of 6.77 indicated that the experimental group achieved higher than their control group counterparts. This result was confirmed on null hypothesis one (H_{01}) presented in Table 4 that, there is significant difference between the post-test mean achievement score of auto-mechanics students in science and technical colleges exposed to multimedia instructional approach and their counterparts exposed to lecture method. The significant difference is attributed to the treatment given to the experimental group. It implies therefore that, multimedia instructional approach has significant effect on auto-mechanics students' achievement in science and technical colleges in Benue State, Nigeria. This finding is in line with Ryan (2011) who confirmed that multimedia has the potential and functionality to enhance achievement and retention of knowledge compared to lecture method.

The finding from the descriptive statistics presented in table 2 shows that both the low-ability level students and the high-ability level students performed equally when exposed to multimedia instructional approach. The null hypothesis two (H_{02}) also confirmed that, no significant difference exists between the post-test mean achievement score of low-ability level students and high-ability level students of auto-mechanics exposed to multimedia instructional approach. Similarly, the result of the descriptive statistics presented on table 3 also shows that, both male and female students performed equally when exposed to multimedia instructional approach. This finding was confirmed in null hypothesis three (H_{03}) that, no significant difference exists between the mean achievement score of male and female students of auto-mechanics in science and technical colleges exposed to multimedia instructional approach. All the findings presented on tables 2 and 3, confirmed on H_{02} and H_{03} respectively, are consistent with Lowman, (2006) that teaching method and teaching aids used by a teacher to present knowledge have significant influence on students' achievement irrespective of ability level and gender. To this end, multimedia instructional approach which motivates students to learn by providing an authentic learning environment,

thereby influencing students' achievement should therefore be integrated with lecture method.

Conclusion

Comparing lecture method with multimedia instructional approach employed for the study, there exist a difference in the post-test mean achievement score of the students in the control and the experimental groups. The results statistically indicate that multimedia instructional approach has significant effect on auto-mechanics students' achievement irrespective of ability-level and gender. This means that the effect of students' ability-level and gender can be greatly neutralized with multimedia instructional approach. In conclusion therefore, multimedia instructional approach which has significant effect on students' achievement of auto-mechanics students in science and technical colleges in Benue State is more effective in helping students to learn auto-mechanics trade than the lecture method.

Recommendations

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

- (i) Multimedia instructional approach should to be integrated in the teaching of auto-mechanics trade.
- (ii) Workshops should be organized for technical teachers on development and application of multimedia packages for enhanced teaching and learning of auto-mechanics trade.
- (iii) Visual libraries should be provided in science and technical colleges for enhanced learning of auto-mechanics trade.

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STRATEGIES FOR STRENGTHENING STUDENTS' ENROLMENT IN WOODWORK
TECHNOLOGY EDUCATION OF FEDERAL UNIVERSITY OF
TECHNOLOGY, MINNA, NIGERIA

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Abstract

The study identified problems associated with low enrolment of students in Woodwork Technology Education programme and strategies for strengthening students' enrolment in the programme at Federal university of Technology, Minna, Nigeria. Two research questions and two hypotheses were formulated to guide the study. The population for the study constituted students and woodwork lecturers of Department of Industrial and Technology Education, Federal University of Technology, Minna, Nigeria. The total population used for the study was 206 respondents. Data obtained were analyzed using mean, standard deviation. The null hypotheses were tested using Z- test statistical tool at 0.05 level of significance. The finding of the study revealed that low enrolment of students in Woodwork Technology Education programme is attributed to Woodwork lecturers' behaviour, parents' attitude to Woodwork Technology and peer group influence. It is recommended that Guidance counselors should play their roles by guiding students when choosing career, modern facilities should be provided for teaching woodwork and Woodwork lecturers should exhibit good behaviour by attending to students problems and encouraging them to enrol in Woodwork Technology Education programme. This can be done by telling the students the benefits they will derive from the course after graduation.

Keywords: Enrolment, Federal University of Technology, Strategy, Strengthening, Woodwork technology

Introduction

Technology education is the type of education that is designed to prepare learners to teach technical courses, be self employed and/or be employer of labour. Bebbiafla (2003) stressed that technology education is meant for preparing individuals for employment in recognized occupation. Technology teachers teach students how to solve problems and evaluate the results in a systematic way that is essential in today's world of technology (Bjorkquist & Zuga, 2003).

Woodwork technology as a course is related to engineering and it deals with wood. It is one of the most important programmes in technology education and has contributed effectively to the development of many nations. Woodwork technology is concerned with the use of wood. Wood is used for construction work. It could be used for structural, furniture or road construction work. The responsibilities of woodwork technologists are varied but generally fall into the broad categories of production and maintenance of woodwork items. Woodwork technology has played a key role in the development of the environment and woodwork technologists have contributed effectively to the welfare and economic development of many nations. It is an acceptable fact that no society can develop or reach the highest level of economic or technological development without using skilled personnel such as woodwork technologists.

Woodwork Technology Education is an aspect of education that leads to acquisition of theoretical knowledge and practical skills relating to construction using woodworking machines and hand tools, and as well as maintenance of woodwork items. Woodwork Technology educators impart both theoretical knowledge and practical skills to learners so that they can be self employed after completing a particular module or course of study. The enrolment of students in Woodwork Technology Education programme at Federal University of Technology, Minna, Nigeria has not been encouraging. Few students enrolled in Woodwork Technology Education while many of them did not show interest in the course. The problem associated with the low enrolment of students in the programme has not been identified by the host Department or Institution. At present, enrolment in Woodwork Technology Education is still very low when compared to other programmes in the Department of Industrial and Technology Education (ITE) of the University. In 2008/2009 academic session, students' enrolment in different programmes in Industrial and Technology at Federal University of Technology, Minna, Nigeria were as follows: Automobile Technology Education 28, Building Technology Education 18, Electrical/Electronics Technology Education 28, Metalwork Technology Education 14 while Woodwork Technology Education 4 (FUT, Minna, ITE Dept, Examination Office, 2009) . In 2015/2016 academic session, Woodwork Technology Education students were only 7 (FUT, Minna, ITE Dept, Examination Office, 2016). If this trend of enrolment is not checked, the possibility of having trained Woodwork technologists, Woodwork technology educators and Woodwork technicians and so on to meet the manpower needs for technological growth in Nigeria may be a problem in future. In addition, to get teachers of Woodwork to teach at post primary and secondary school level will be a problem.

Statement of the Problem

It is a fact that enrolment in Woodwork Technology Education in Federal University of Technology, Minna, Nigeria is not encouraging. In 2012/2013 academic session, students' enrolment into different programmes in Industrial and Technology Education at Federal University of Technology, Minna, Nigeria was as follows: Automobile Technology Education 20, Building Technology Education 20, Electrical/Electronic Technology Education 37, Metalwork Technology Education 21 and Woodwork Technology Education 4 (FUT, Minna, ITE Dept, Examination Office, 2013). In 2014/2015 academic session, Automobile Technology Education 20, Building Technology Education 29, Electrical/ Electronics Technology Education 35, Metalwork Technology Education 36 and Woodwork Technology Education 29 (FUT, Minna, ITE Dept, Examination Office, 2015). This low enrolment in Woodwork Technology Education has been a problem. The researcher wonders whether the low enrolment in Woodwork Technology Education could be attributed to the fact that it demands the use of energy and high level of co-ordination. Reasons for students' preference for other programmes such as Automobile Technology Education, Building Technology Education, Electrical/Electronic Technology Education and Metalwork Technology Education by students in the Department are not known. This poses a threat to Woodwork Technology Education which may result to shortage of workforce in future. It is on this basis that this research, strategies for strengthening enrolment of students in Woodwork Technology Education programme at Federal University of Technology, Minna, Nigeria was carried out.

Purpose of Study

The purpose of the study was to determine strategies for strengthening enrolment of students in Woodwork Technology Education at Federal University of Technology, Minna, Nigeria. Specifically, the study sought to:

- (i) Identify problems responsible for low enrolment of students in Woodwork Technology Education at Federal University of Technology, Minna, Nigeria.

- (ii) Find out strategies for strengthening students' enrolment in Woodwork Technology Education at Federal University of Technology, Minna, Nigeria.

Research Questions

In this study the following research questions were raised.

- (i) What are the factors responsible for low students' enrolment in Woodwork Technology Education of Federal University of Technology, Minna, Nigeria?
- (ii) What are the strategies to be adopted for strengthening students' enrolment in Woodwork Technology Education of Federal University of Technology, Minna, Nigeria?

Hypotheses

- H₀₁: There is no significant difference in the mean responses of students and woodwork lecturers on factors responsible for low students' enrolment in Woodwork Technology Education at Federal University of Technology, Minna, Nigeria.
- H₀₂: There is no significant difference in the mean responses of students and Woodwork lecturers on the strategies to be adopted for strengthening students' enrolment in Woodwork Technology Education at Federal University of Technology, Minna, Nigeria.

Methodology

Research Design

The research design adopted in this study was a case study design. A case study was adopted because the study involves only the Department of Industrial and Technology Education, Federal University of Technology, Minna, Nigeria.

Area of study

The study was carried out in the Department of Industrial and Technology Education of Federal University of Technology, Minna, Nigeria.

Population and Sampling Technique

The total population for this study comprised of students and Woodwork lecturers in Industrial and Technology Education Department of Federal University of Technology, Minna, Nigeria. All 300 level, 500 level students and woodwork lecturers from Industrial and Technology Education Department of Federal University of Technology, Minna were used for the study. The respondents from 300 level were 86 and 500 level were 119 while woodwork lecturers were 5. The total population of the study was 210 and all was used for the study. Three hundred (300) and 500 level students were used for the study because students specialize or choose area of specialization in 300 level. Four hundred (400) level students were on teaching practice and industrial training so students in these levels were not in the campus. Therefore, they were not used for the study. There was no sampling since the population wasn't much.

Instrument for Data Collection

Questionnaire was used for data collection. Section 'A' sought for information from respondents on problems associated with low enrolment of students in woodwork technology while section 'B' sought for information from respondents on strategies for strengthening enrolment of students in woodwork technology.

Validation of the Instrument

The drafted copies of the questionnaire were given to three experts in the Department of Industrial and Technology Education, Federal University of Technology Education for face

and content validation. Final draft was produced after the validation of the instruments by experts.

Administration of the Instrument

The researchers administered the questionnaire personally and its collection was also done by the researchers. The questionnaire was given to 205 students and 202 questionnaire were returned while in the case of woodwork lecturers, 4 were returned out of 5. This means 206 questionnaire was received out of 210 making 98.10% return rate.

Method of Data Analysis

In analyzing the data collected, the researchers made use of mean, standard deviation and Z-test statistical tool. Four point rating scale of Strongly Agree (SA) 4 points, Agree (A) 3 points, Disagree (D) 2 points, Strongly Disagree (SD) 1 point was used.

To determine the acceptance level of the questionnaire items, a mean score of 2.50 was used as decision point between agree and disagree. In order words, any response or item with a mean score of 2.50 and above was considered accepted while items having mean score below 2.50 was considered rejected.

Hypotheses were tested using Z-test statistics at 0.05 level of significance. Any item having its value equal or below 1.96 was accepted while those above 1.96 was rejected.

Results

Research Question 1: What are the factors responsible for low students' enrolment in Woodwork Technology Education of Federal University of Technology, Minna, Nigeria?

Table 1: Mean responses of students and Woodwork lecturers on the factors responsible for low students' enrolment in Woodwork Technology Education

S/N	Items	N ₁ =202, N ₂ =4			Remark
		\bar{X}_1	\bar{X}_2	\bar{X}_t	
1	Students do not like handling and working with woodworking machine and tools.	3.14	3.36	3.25	Agree
2	Students always seek for help during woodwork practical period.	3.10	3.48	3.29	Agree
3	Students do not like woodwork technology education because of some lecturers' behaviour and attitude.	3.67	3.34	3.51	Agree
4	Students do not like woodwork technology education because their friends hate it.	3.21	3.38	3.30	Agree
5	Students do not like woodwork technology education because their parents do not like it.	3.69	3.25	3.47	Agree
6	Students do not like woodwork technology education because it has no bright future.	2.57	1.70	2.14	Disagree
7	Students do not like woodwork technology education because people call the experts carpenter.	3.64	3.60	3.62	Agree
8	Students do not like woodwork technology education because the workshop is not well-equipped.	2.07	2.25	2.16	Disagree
9	Students do not like woodwork technology education because their teachers lack practical skill.	2.0	1.88	1.96	Disagree
10	Students do not like woodwork technology education because people feel it is a course for student with low I.Q	3.57	3.63	3.60	Agree

Key: N_1 = Number of students
 N_2 = Number of woodwork lecturers
 \bar{X}_t = Average mean of students and woodwork lecturers
 \bar{X}_1 = Mean of students' responses
 \bar{X}_2 = Woodwork lecturers' responses

Table 1 reveals that the respondents agreed with item 1, 2, 3, 4, 5, 7 and 10 with average mean score of 2.50 and above. While the respondents disagreed with item 6, 8 and 9 with average mean score below 2.50. This means respondents did not agree with these items as factors responsible for low students' enrolment in woodwork technology education.

Research Question 2: What are the strategies to be adopted for strengthening students' enrolment in Woodwork Technology Education of Federal University of Technology, Minna, Nigeria?

Table 2: Mean responses of students and Woodwork lecturers on the strategies for strengthening students' enrolment in Woodwork Technology Education

S/N	Items	N ₁ =202, N ₂ =4			Remark
		\bar{X}_1	\bar{X}_2	\bar{X}_t	
1	Students' interest should be considered in their choice of woodwork technology education.	3.60	3.59	3.60	Agree
2	Necessary facilities needed for woodwork technology education course should be provided.	3.52	3.46	3.49	Agree
3	Scholarship should be awarded to the best graduating student in woodwork technology education.	3.57	3.34	3.46	Agree
4	Guidance and counseling for career choice should be provided in Industrial and Technology Education Department	3.71	3.77	3.74	Agree
5	Public seminar and enlightenment programme should be organized by woodwork technology education experts on career opportunities for graduates of woodwork technology education.	3.50	3.48	3.49	Agree
6	Parents should be enlightened about woodwork technology programme.	3.76	3.05	3.46	Agree
7	Creation of job opportunities for woodwork technology education graduates.	3.69	3.68	3.69	Agree
8	Students should be properly guided in the choice of trade.	3.43	3.48	3.46	Agree
9	Provision of more role models will help to increase students' enrolment in woodwork technology education.	3.10	3.16	3.13	Agree
10	Field trips/ Excursion for beginning students to companies and industries should be organized to enhance students' interest in woodwork technology education.	3.67	3.38	3.53	Agree
11	There should be provision of well equipped library with woodwork textbooks for effective academic work.	3.64	3.60	3.62	agree
12	Educating other students about woodwork will improve students' interest in woodwork technology education.	3.14	3.34	3.24	Agree

Table 2 reveals that the respondents agreed with all the items. This shows that respondents agreed with these items as strategies to be adopted for enhancing students' enrolment in Woodwork Technology Education of Federal University of Technology, Minna, Nigeria.

Hypothesis Testing

Hypothesis 1: There is no significant difference in the mean responses of students and Woodwork lecturers on factors responsible for low students' enrolment in Woodwork Technology Education of Federal University of Technology, Minna.

Table 3: Z–test analysis of respondents regarding the factors responsible for low students' enrolment in Woodwork Technology Education, Federal University of Technology, Minna, Nigeria

S/N	RESPONDENTS	Number	\bar{X}	SD	df	z-cal	z-table
1	Students	202	3.14	1.03	204	-0.19	± 1.96
2	Woodwork lecturers	4	3.18	1.00			

Key: Not significant = NS, df = 204

The analysis in table 3 shows that the z-cal is -0.19 and the z-tab is ± 1.96 . The z-cal is lower than the z-tab. Therefore, null hypothesis is accepted. This means that there is no significant difference in the mean responses of respondents on factors responsible for low enrolment of students in woodwork technology education of Federal University of Technology, Minna, Nigeria.

Hypothesis 2: There is no significant difference in the mean responses of students and woodwork lecturers on the strategies to be adopted for strengthening students' enrolment in Woodwork Technology Education of Federal University of Technology, Minna.

Table 4: Z–test analysis of respondents regarding the students on the strategies to be adopted for enhancing students' enrolment in Woodwork Technology Education, Federal University of Technology, Minna, Nigeria

S/N	Respondents	Number	\bar{X}	SD	df	z-cal	z-table
1	Students	202	3.22	1.03	204	-0.34	± 1.96
2	Woodwork lecturers	4	3.29	0.92			

Key: Not significant = NS, df = 204

The analysis in Table 4 shows that the z-cal is - 0.34 while the z-tab is ± 1.96 . The z-cal is lower than the z-tab. Therefore, null hypothesis is accepted. This shows that there is no significant difference in the mean responses of respondents on strategies for strengthening students' enrolment in Woodwork Technology Education of Federal University of Technology, Minna, Nigeria.

Discussion

It is clearly seen that students and Woodwork lecturers agreed that factors responsible for low enrolment of students in Woodwork Technology Education can be attributed to the fact that experts are called carpenters, and parents' attitudes towards Woodwork Technology Education. Inyiagu (2015) reported that students lack interest in technical college programme because their parents have negative attitude towards technical and vocational education.

The findings in Table 2 revealed strategies to be adopted for strengthening students' enrolment in Woodwork Technology Education to include: provision of modern facilities for teaching Woodwork Technology; parents should be enlightened about Woodwork Technology programme; students should be properly guided in the choice of career by

Guidance Counselor. Raji (2006) explained that absence of training material could discourage students from technical programmes.

Conclusion

Based on the findings of this study, attitudes of parents towards Woodwork Technology; peer group influence and calling experts carpenters affect students' enrolment into Woodwork Technology programme. Therefore, students should be enlightened during students' orientation at the beginning of every academic session about Woodwork Technology and they should be informed that experts in Woodwork Technology are not called Carpenter and the opportunities available to graduates of Woodwork Technology Education should be explained to them. Guidance counselors can play active role also by providing information on importance of Woodwork and job opportunities available for graduates of woodwork technology education. The above information can assist in strengthening students' enrolment in the course.

Recommendations

Based on the findings of the research, the following recommendations are:

- (i) Guidance counselors should provide relevant information about Woodwork Technology Education and educate students about the benefits they will derive from the course after graduation.
- (ii) Woodwork Technology workshop should be equipped with modern facilities. This can aid in improving students' enrolment in the course.
- (iii) Woodwork Technology Education section should partner with industries, companies and ministries in order to strengthen the programme. This can be done through field trip and inviting resource persons to talk to students before choosing area of specialization. This can assist in improving students' enrolment in the course.
- (iv) Woodwork lecturers should pay attention to students' problem when their assistance is sought especially with reference to the course. This can also enhance students' interest in the course leading to increase in enrolment in the programme.
- (v) Lecturers in Woodwork Technology Education should encourage students to enrol in the course by using themselves as role models and also by telling the students the benefits of being Woodwork Technology experts.

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