



Réseau Ouest et Centre Africain de Recherche en Education
Educational Research Network for West And Central Africa

***COST-REDUCING STRATEGIES AND LABORATORY
MANAGEMENT TECHNIQUES FOR BIOLOGY AND
CHEMISTRY TEACHERS IN THE GAMBIA AND NIGERIA***

ERNWACA - THE GAMBIA

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Cost –Reducing Strategies and Laboratory Management Techniques for Biology and Chemistry Teachers in The Gambia and Nigeria

Object of the Study:

The study explored the impact of experience, qualification, training programmes and location on the use of strategies involving cost-reduction and on the use of techniques involving laboratory management. The design, a survey was used in executing the study. The sample comprised 950 chemistry and biology teachers from Nigeria and The Gambia. Of this number which was selected on the basis of multi-stage random sampling technique, followed by stratification, the variables got were as follows: Nigerian Biology and Chemistry teachers 800, their Gambian counterparts 150, all biology teachers irrespective of country = 500, their chemistry counterparts 450, Urban-based teachers 225; their rural based counterparts 225. The two questionnaire developed and validated by the researcher were used in collecting the pertinent data. Content and face validities were established for the instrument. The research questions were answered using means and standard deviations while the hypotheses were tested using either two-way analysis of variance or critical ratio at a 0.05 level of significance, as appropriate.

Overall Summary of Major Findings:

Chemistry and biology teachers moderately employed cost-reducing strategies and laboratory management techniques. However their use of these strategies for each of the 15 items indicated in the first questionnaire and their use of the techniques for each of the 24 items indicated in the second questionnaire were classified into 'extensive', 'moderate' and 'sparse' for the first set of items, and 'efficient', 'moderately efficient' and 'inefficient' for the second set of items. The study in addition indicated that urban-based chemistry and biology teachers whether for the use of cost-reducing strategies or for the use of laboratory management techniques, employed these skills better than their rural-based counterparts. The study also showed that whereas chemistry and biology teachers with high experience, high qualification and high participation in in-service training programme extensively used cost-reducing strategies and laboratory management techniques, their counterparts with average qualification, average experience and average participation in in-service training programmes, played second fiddle roles, while the lowly qualified, experienced and low participants in in-service training brought up the rear although were, in some cases, as moderate in the use of it as their average 'in status' counterparts. Chemistry and biology teachers in Nigeria performed better than their Gambian counterparts in the use of cost-reducing strategies and laboratory management techniques. Chemistry teachers in both Nigeria and The Gambia employed these techniques, whether it is in the use of cost-reduction or in the use of laboratory management techniques, better than their biology counterparts. The study equally showed that at 0.05 level of significance, the following variables were significant factors in the use of cost-reducing strategies: - experience, participation in in-service training programme, qualification, location, country of

residence, subject background. Similarly at the same level of probability the following factors significantly influenced the teachers' use of laboratory management techniques: experience, participation in in-service training programme, qualification, location, subject area.

Recommendations

Finally emphasis was placed on cheaper but adequate experimental designs and on simpler laboratory skills. The successful application of each would depend on the periodic update of skills through organized training programmes. For experienced and lowly qualified teachers, their lack of experience and qualification can be counterbalanced by organized pre-service training programmes replicated in defined periods. Furthermore, the distribution imbalance between urban-based and rural-based schools can be redressed by ensuring that enabling facilities (materials and human) on which good laboratory management is predicated upon are improved upon in rural areas i.e. conditions that make for life and living are enhanced in rural areas.

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Chapter One

Introduction

Background to the Study

The facilities for science education are fast dwindling. For this reason there is dire need for science teachers to apply innovative strategies that call for cost-reduction of materials and methods. It is also important that modern techniques that invite the use of good laboratory management should be invoked. The need for cost-reducing strategies and good laboratory management techniques has more than ever before become very necessary. In the first instance, activity-oriented curricula have imposed a high demand on laboratory facilities, without which, effective teaching and learning cannot take place (Bomide, 1985). Speaking in the same vein, Alonge (1991) had contended that there had been an explosion in school enrolment, a situation that had been exacerbated by a declining economy. With such an unweildiness in the number of students admitted, the availability of science materials will be short-changed, thus making teaching and learning most ineffective.

Ogunniyi (1998) blamed bad science teaching on lack of laboratory assistants, teachers' inability to improvise and careless attitude of students to laboratory facilities among others. Mbaekwe (1993) argued that education planners, especially those of them outside the realm of science, would not see why the running of science education would cost more than those of other disciplines, blaming them for this debilitating situation. In addition, according to him, the provision of facilities could not keep pace with the rise in students' population, and above all, the various governments within the underdevelopment catchments were strapped of cash or so it seemed.

To execute the discovery method which has been widely acknowledged to be the linch-pin of pedagogy in the sciences, is monetarily exerting if it has to be executed successfully, because it will require a lot of money to purchase equipment and materials. This view has variously been put across by Mani (1993), Mojekwu (1999), Chukwuemeka (1999), all leading to the inescapable fact that cost-reducing strategies (CRS) are urgently needed. CRS according to Mogbo (1993) cannot be tagged to a definite reference point. Its multi-dimensional character includes the following: improvisation, role simulation, conscious use of locally available materials judicious application of expendables, use of recycling procedures, control over potential fire hazards, control over the possibility of glassware casualty, ability to minimize the contamination of reagents, repairs and maintenance of equipment by the teachers themselves, production/marketability/profitability of science products locally manufactured and sold for profit by the students themselves under guidance, use of small-scale experiments, and the reduction of pilferage of laboratory materials. Each of these characteristics is in its own right cost-reducing.

Laboratory management technique (LMR), according to Mogbo (1992) is a contrivance that enables the chemistry teacher to cope with or coordinate all the complex interactions within the laboratory. They include ordering, stocking, storage and safety of all equipment, and are so coordinated such that pedagogic activities within the arrangement are maximized to the overall benefit of teacher and taught and cost minimized to the overall advantage of the department concerned.

Evaluation of Cost-Reducing Strategies and Laboratory Management Techniques

Every science teacher should reflectively address himself to the problem of applying cheaper alternatives or prudent methods in the use of laboratory management technique. In doing so, he may discover that the confidence generally reposed on conventional materials is not always justifiable. Granted that there may be problems of accuracy, precision, usability (difficulty of use, duration it takes to accomplish its objectivity, inconveniences encountered such as messiness), it is worthwhile to note that at the secondary school level, where objectivity of observation and the internalization of scientific processes and skills are more important than accuracy and precision, the use of cost-reducing strategies and laboratory management techniques may not be worthless (Balogun, 1992). Visible and tactile experiences gained from it certainly supplement verbal descriptions and explanations. But these technical factors become worthless if the teacher is not prepared to commit his professional, creative, technical and ingenious skills readily and willingly to these strategies.

Finally and according to Mkpa and Chukwuemeka (1991), alternative methods and materials must

- a) provide answers to specific principles and problems,
- b) must be simple, readily replicable and durable
- c) must be cheaper than its conventional counterpart
- d) must be functional, and
- e) must serve the purpose for which it is intended.

Statement of the Problem

The open-ended methods involved in the teaching of Biology and Chemistry, as advocated by Mani (1993), Oladimeji(1998), Mojekwu(1999) and Chukwuemeka(1999), call for C.R.S. and LMT, because the practical orientation of science involves high consumption of expendable materials. To compound this, the large class syndrome that characterises the secondary schools in sub-Saharan Region of West Africa increases the chances of consumption (Alonge, 1991) while the careless attitude of students to laboratory materials increases the chances of damage (Ogunniyi, 1998).

With the present rate of inflation and economic depression coupled with a slim-fund base, it is to be expected that replacement with cheaper and more prudent techniques and strategies be found to the teaching of chemistry and biology such that the ultimate learning outcome is not jeopardised. Specifically the study seeks to explore the impact of experience, qualification, in-service programmes and location on the use of techniques involving laboratory management and on the use of strategies involving cost-reduction in the teaching of chemistry and biology in The Gambia and in Nigeria.

Research Objectives

The study was designed to determine:

1. The extent to which chemistry and biology teachers in The Gambia and Nigeria employed cost-reducing strategies collectively as science teachers and collectively in both countries.
2. The extent to which chemistry and biology teachers in The Gambia and Nigeria employed laboratory management techniques collectively as science teachers and collectively in both countries.
3. The extent to which
 - a) chemistry teachers only
 - b) biology teachers only employed
 - I) cost-reducing strategies only
 - II) laboratory management techniques only in The Gambia and in Nigeria.
4. The influences of
 - a) experience
 - b) qualification
 - c) in-service
 - d) location on the extent to which
 - I) chemistry teachers
 - II) biology teachers only in The Gambia and in Nigeria employed cost-reducing strategies and laboratory Management Techniques.

Research Hypotheses

The following research hypotheses apart from forming the bases of the study implied as Research Questions, were answered and tested at 0.05 level of probability. H_{01} : Each of the following variables: experience, qualification, in-service, location was not a significant factor influencing the extent to which

- a) chemistry teachers only
- b) biology teachers only, employ
- I) CRS & LMT in The Gambia and in Nigeria, according to their mean ratings.

Ho₂: The significant difference on the extent to which chemistry teachers and biology teachers employed

- a) CRS
- b) LMT, in The Gambia and in Nigeria was zero, according to their mean ratings.

Ho₃: There was no significant difference in the extent to which secondary school science teachers (chemistry and biology) in The Gambia and their counterparts in Nigeria, employed

- a) CRS
- b) LMT in the teaching of chemistry and biology and in accordance with their mean ratings. Note: With careful permutations and combinations necessitated by the inherent need for comparative studies that call for interdisciplinary studies (chemistry/biology) and transnational studies (The Gambia/Nigeria) the number of hypotheses could add up to twenty or slightly more.

Scope of the Study

The study intended to find out the perception of chemistry and biology secondary school teachers in The Gambia and Nigeria, on their use of CRS and LMT, as well as to determine the influences of experience, qualification, in-service and location on the use of such strategies and techniques. The study also intended to compare the use of CRS and LMT in biology and chemistry and in the two countries under investigation: The Gambia and Nigeria.

Justification of the Study

The study attempted to

1. Reflect the current and true mood of both nations (The Gambia and Nigeria are economically embattled) through prudent and effective spending.
2. Imbue in the chemistry and biology teachers worthwhile virtues manifested by self-reliance, self-sufficiency, prudent spending and a maintenance culture
3. Emphasise cheaper but adequate experimental designs
4. Integrate the respective environments with learning
5. Inculcate simple but correct laboratory skills
6. Encourage creativity and adequate fore-thought in the face of inadequacy
7. Reduce incidents of glassware casualties, incidents of fire and incidents of pilferage.

Chapter Two

The Research Methodology

Method of Investigation

The study was a survey design. It involved chemistry and biology secondary school teachers, on their use of cost-reducing strategies and laboratory management techniques.

Area of the Study

Four distinct geopolitical zones in Nigeria: one each from the East, West, North and a fourth, The Federal Capital Territory were the focus of the study. In view of the small size of The Gambia, and the attendant homogeneity thereto, the area of the study was made up of the whole of The Gambia.

Population of the Study

All biology and chemistry teachers teaching in secondary schools in The Gambia and Nigeria.

Sample Size and Sampling Techniques

The sample size of the study was a projected estimate of 850 chemistry and biology teachers made up of 100 chemistry teachers and 100 biology teachers, from each of the four selected geopolitical zones in Nigeria and 100 biology teachers and 50 chemistry teachers from The Gambia.

The sample was drawn as follows: By means of multi-stage random sampling technique, 100 chemistry teachers and 100 biology teachers were randomly selected from each of the four selected geopolitical zones which in turn were randomly selected from a total of six geopolitical zones. The sample was purposive to the extent that it reflected the distinctiveness immanent in the character and historical antecedents of Nigeria; one from the East, one from the West, one from the North and one from the Federal Capital Territory. The 100 biology teachers and 50 chemistry teachers in The Gambia were also selected by multi-stage random sampling techniques. The variables within each sampled area was carried out by stratified random sampling technique as follows:

Qualification : Highly qualified 30%; Moderately Qualified 35%; Lowly Qualified 35%

Experience : Highly experienced 30%; Moderately experienced 35%; Lowly experienced 35%

Location	Urban 50%	Rural 50%
Inservice programme	High participation	25%
	Moderate participation	35%
	Low participation	40%

Analysis of Data

Instrument: In this study, a questionnaire was administered to Biology and Chemistry teachers who were expected to respond to items based on the supply type/data blank or the select type /check list. The questionnaire was divided into three sections as follows:

Background : This included qualification, location of school, experience and participation in in-service training programme.

Use of Cost-Reducing Strategies : The questionnaire relevant to C.R.S. were based on a five point Likert rating scale as follows: 5 = most extensively employed; 4 = extensively employed; 3 = moderately employed; 2 = sparingly employed and 1 = not employed. Teachers were expected to provide information on the extent to which they intended to use the 15 CRS items indicated in Appendix A.

Use of LMT : The questionnaire involved the use of a five point Likert rating scale as follows: 5 = always; 4 = frequently; 3 = occasionally; 2 = rarely; 1 = never. Teachers also indicated their extent of involvement with 24 LMT items detailed in Appendix D.

Validation of the Instrument

In order to ensure the face and content validity of the questionnaire, draft copies were distributed to two experts in measurement and evaluation and two experts in chemistry and biology

Reliability of the Instrument: A test-retest estimate on reliability was obtained by administering a test on a relatively small group of 40 chemistry teachers and 40 biology teachers. The same test was administered to the same teachers after an interval of one month. After correlating the two sets of scores, the following correlation coefficients were obtained, CRT = 0.88, LMT = 0.91.

Methods of Data Analysis

Ho₁: Location involved two variables. It was tested using t. Experience, Qualification and In-service involved in each case three variables.

Each was tested using ANOVA.

Ho₂: For the variables biology versus chemistry, the null hypothesis was tested using t test.

Ho₃: For the variables The Gambia versus Nigeria, the null hypothesis was tested using t.

The research questions (not stated but could be deduced from the Research objectives were answered using means and standard deviations. The extent to

which chemistry and biology teachers participated in in-service training programmes was (after necessary computations based on each teacher's scores for all in-service programmes attended over time for the past ten years) categorized into three as follows:

0 – 2 participation = low participation,
3 – 4 participations = average participations;
Above 5 participations = High participation.

Experience of chemistry and biology teachers was classified into:

0 – 5 years = low experience;
6 – 15 years = Average Experience;
Above 15 years = High Experience.

Qualification of Chemistry and Biology teachers was classified into:

HTC/HND/NCE = Low Qualification;
First degree = Average Qualification;
Masters degree and Above = High Qualification.

Location of teachers was classified into Urban/Rural.

The extent to which teachers employed CRS for each of the 15 items in the questionnaire was computed as follows:

Above 3.50 = Extensively Employed
2.50 – 3.50 = Moderately Employed
1.50 – 2.49 = Sparingly Employed
Below 1.50 = Not Employed.

Similarly the efficiency of chemistry and biology teachers in employing LMT for each of the 24 items in the questionnaire was computed using

Above 3.50 = Efficient
2.50 – 3.50 = Moderately Efficient
1.50 – 2.49 = Weakly Efficient
Below 1.50 = Inefficient.

Chapter three

Presentation of data and Result

In this chapter, the presentation of data and results was organised around the research questions and statistical hypotheses that guide the study.

A. **Key to Items on Cost-reducing Strategies (CRS)**

A = Use of substitutes when the conventional equipment are not available

B = Use of substitutes when the conventional chemicals are not available

C = Conscious application of locally available materials

D = Economizing the quantity of reagents employed during practical work

E = Exercise of care over furnishings through effective supervision

F = Use of recycling procedures

G = Control over potential fire hazards

H = Extent of control over the possibility of glass ware casualty

I = Minimizing the contamination of reagents

J = Ability to quantify and record the amount of expendables committed to an experiment

K = Repairs and maintenance of equipment

L = Ability to quantify and record the amount of expendables committed to an experiment

M = Extent at which valuable experimental products such as soap, are made and stored ready for the market

N = Use of small scale experiments or group experiments when the conventional materials are not within the reach of each student

O = Competency at simulating a real-life situation

B. **Key to Items on Laboratory Management Techniques**

A = Consideration of catalogue price from different companies before making a purchase

B = Completion of items to be purchased with a catalogue that has not become obsolete

C = Priority placement of items that have become indispensable while making a purchase

D = Use of damages and breakage book. Use of accident and first aid book

E = Ensuring that the delivery note accompanying an order is identical with the item ordered

F = Ensuring that the items are functionally and structurally correct as ordered before acceptance

G = Ensuring that the correct numbers arrive

H = Ensuring that all the equipment are in full working conditions

I = Ensuring that each piece of equipment is kept in a specified place

J = Insisting on the credential of suppliers before hiring their services

K = Ensuring that each cupboard should bear a general label indicating the type of material it contains

L = Providing for suitably sized drawers for the storage of glassware

- M = Use of stock book
 N = Ensuring that the quantity of flammable materials do not exceed one year
 O = Ensuring that all reagent bottles are labelled
 P = Insisting that reagent bottles that contain volatile, toxic or combustible materials are marked with red to indicate danger
 Q = Ensuring that gas cylinders are stored outside the laboratory building
 R = Ensuring that reagent bottles are shelved where they cannot easily be knocked off
 S = Ensuring that beakers are stored individually and not in nests
 T = Ensuring that chemicals that react together are not stored together
 U = Ensuring that chemical that are susceptible to photochemical disintegration are stored in coloured bottles
 V = Ensuring that a regular tag is kept on overall quantity of consumables as they are used up
 W = Ensuring that planned safety measures are adopted to prevent injury to persons and equipment.

Research Question 1

To what extent do chemistry teachers in Nigeria and The Gambia employ cost-reducing strategies?

The data answering the above research questions are presented in Table I

Table I

<u>S/N</u>	<u>Cost-reducing Strategic Items</u>	<u>Mean</u>	<u>Standard Deviation (S.D)</u>	<u>Interpretation</u>
1.	A	2.73	1.11	Moderately Employed
2.	B	2.09	1.17	Sparingly Employed
3.	C	2.80	1.33	Moderately Employed
4.	D	3.53	1.12	Extensively Employed
5.	E	4.17	0.60	Extensively Employed
6.	F	1.67	0.88	Sparingly Employed
7.	G	3.63	0.99	Extensively Employed
8.	H	4.05	0.72	Extensively Employed
9.	I	2.86	1.70	Moderately Employed
10.	J	4.43	0.60	Extensively Employed
11.	K	1.74	0.88	Sparingly Employed
12.	L	3.09	1.30	Moderately Employed
13.	M	1.58	0.40	Sparingly Employed
14.	N	3.22	1.05	Moderately Employed
15.	O	2.19	1.21	Sparingly Employed
Overall Employed		43.76	7.70	Moderately

The alphabets in small letters correspond to the keyed items earlier on explained.

Research Question 2

How efficient are the chemistry teachers on laboratory management techniques both in the Gambia and Nigeria?

The data answering the above question are contained in Table 2.

Table 2

<u>S/N</u>	<u>Laboratory Mgt. Techniques</u>	<u>Mean</u>	<u>Standard Deviation (S.D)</u>	<u>Interpretation</u>
1.	A	4.01	0.85	Efficient
2.	B	3.72	0.96	Efficient
3.	C	4.35	0.50	Efficient
4.	D	2.75	1.19	Moderately Efficient
5.	E	4.06	0.73	Efficient
6.	F	3.50	0.60	Moderately Efficient
7.	G	4.44	0.68	Efficient
8.	H	3.41	0.93	Moderately Efficient
9.	I	3.16	1.23	Moderately Efficient
10.	J	2.12	1.07	Inefficient
11.	K	3.28	1.30	Moderately Efficient
12.	L	3.48	0.96	Moderately Efficient
13.	M	3.76	1.16	Efficient
14.	N	3.28	1.30	Moderately Efficient
15.	O	1.80	1.37	Inefficient
16.	P	4.29	0.48	Efficient
17.	Q	1.79	1.02	Inefficient
18.	R	4.52	0.17	Efficient
19.	S	3.94	0.28	Efficient
20.	T	2.95	1.08	Moderately Efficient
21.	U	3.41	1.07	Moderately Efficient
22.	V	3.46	0.94	Moderately Efficient
23.	W	2.05	1.25	Inefficient
24.	X	3.95	0.84	Efficient
Overall		81.30	11.17	Moderately
Efficient				

Research Question 3

To what extent does experience influence the chemistry teachers use of cost-reducing strategies in Nigeria and The Gambia?

Table 3

	Low Experience	Moderate Experience	High Experience
X	38.13	43.53	53.86
S.D.	4.18	5.77	4.60
N	158	157	135

Research Question 4

To what extent does participation in in-service training programme influence the chemistry teachers' use of cost-reducing strategies in Nigeria and The Gambia?

Table 4

	Low Participation	Average Participation	High Participation
X	38.26	42.84	52.45
S.D.	4.08	4.58	5.32
N	180	158	112

Research Question 5

To what extent does qualification influence the chemistry teachers' use of cost-reducing strategies in Nigeria and in The Gambia?

Table 5

	Low Qualification	Average Qualification	High Qualification
X	39.03	41.92	54.19
S.D.	4.44	4.65	4.56
N	157	158	135

Research Question 6

What is the influence of location on chemistry teachers' use of cost-reducing strategies in Nigeria and The Gambia?

Table 6

	Urban	Rural
X	50.68	36.63
S.D.	4.02	5.07
N	225	225

Research Question 7

How does gender affect the extent to which chemistry teachers in Nigeria and The Gambia had used cost-reducing strategies.

In view of the fact that only two female participated in this project in The Gambia, the influence of gender was not strategically considered.

Research Question 8

How far does the experience of chemistry teachers influence their use of laboratory management techniques in Nigeria and the Gambia?

Table 7

	Low Experience	Average Experience	High
Experience			
X	73.93	81.15	94.25
S.D.	5.77	10.99	5.25
N	158	157	135

Research Question 9

What is the influence of participation in in-service training programme on chemistry the teachers' use of laboratory management technique in Nigeria and The Gambia?

Table 8

	Low Participation	Average Participation	High Participation
X	74.05	79.78	93.20
S.D.	6.01	8.86	5.76
N	180	158	112

Research Question 10

To what extent does qualification influence the chemistry teachers' use of laboratory management techniques in Nigeria and The Gambia?

Table 9

	Low Qualification	Average Qualification	High Qualification
X	70.10	80.92	86.22
S.D.	5.50	9.15	5.45
N	156	157	137

Research Question 11

To what extent does location influence the chemistry teachers' use of laboratory management techniques in Nigeria and The Gambia?

Table 10

	Urban	Rural
	85.78	72.98
	5.50	9.02
N	225	225

Research Question 12

To what extent do biology teachers in Nigeria and The Gambia employ cost-reducing strategies?

Table 11

S/N	Cost-reducing Strategies	X (Mean)	S.D.	Interpolation
1.	A	3.01	0.91	Moderately Employed
2.	B	2.24	1.32	Sparingly Employed
3.	C	3.79	0.88	Extensively Employed
4.	D	2.94	1.05	Moderately Employed
5.	E	3.24	0.94	Moderately Employed
6.	F	1.48	0.59	Not Employed
7.	G	1.52	1.42	Sparingly Employed
8.	H	2.45	1.24	Sparingly Employed
9.	I	2.52	1.34	Moderately Employed
10.	J	3.56	0.83	Extensively Employed
11.	K	1.33	1.67	Not Employed
12.	L	2.99	1.11	Moderately Employed
13.	M	1.04	0.70	Not Employed
14.	N	1.47	0.68	Sparingly Employed
15.	O	2.00	0.89	Sparingly Employed
Overall mean		35.57	6.54	Sparingly Employed

A, B, C, D, ... are the cost-reducing items as in Chemistry.
N = 500

Research Question 13

To what extent do biology teachers in Nigeria and The Gambia employ laboratory management techniques ?

Table 12

S/N	Laboratory Mgt. Techniques	X	S.D.	Interpretation
1.	A	3.99	0.79	Efficient
2.	B	4.21	0.84	"
3.	C	3.85	0.88	"
4.	D	1.48	0.77	Inefficient
5.	E	3.66	1.24	Efficient
6.	F	3.37	1.07	Moderately Efficient
7.	G	3.52	1.14	Efficient
8.	H	3.14	0.92	Moderately Efficient
9.	I	3.49	0.87	" "
10.	J	1.64	0.79	Inefficient
11.	K	2.74	1.22	Moderately Efficient
12.	L	2.21	1.41	Weakly Efficient
13.	M	3.04	1.25	Moderately Efficient
14.	N	2.74	1.22	" "
15.	O	1.47	0.85	Inefficient
16.	P	3.49	0.82	Moderately Efficient
17.	Q	1.84	1.47	Weakly Efficient
18.	R	1.92	0.64	" "
19.	S	3.00	0.99	Moderately Efficient
20.	T	3.21	0.87	" "
21.	U	1.32	0.66	Weakly Efficient
22.	V	1.83	1.23	" "
23.	W	2.56	0.98	Moderately Efficient
24.	X	3.69	0.72	Efficient
Overall		67.51	13.22	Moderately Efficient

A, B, C, D, E, ... are the laboratory management items as in Chemistry.

Research Question 14

To what extent does experience influence the biology teachers' use of cost-reducing in Nigeria and The Gambia?

Table 13

	Low Experience	Moderate Experience	High Experience
X	36.14	38.21	40.35
S.D.	4.23	4.93	4.71
	N = 175	N = 175	N = 150

Research Question 15

To what extent does participation in in-service training programme influence the biology teachers' use of cost-reducing strategies in Nigeria and The Gambia ?

Table 14

	Low Participation	Average Participation	High Participation
X	35.86	37.03	44.29
S.D.	4.85	6.62	4.29
N	175	175	150

Research Question 16

How far has qualification affected biology teachers' use of cost-reducing strategies in Nigeria and The Gambia?

Table 15

	Low Qualification	Average Qualification	High Qualification
X	38.21	40.58	47.92
S.D	4.29	5.46	6.33
N	175	175	150

Research Question 17

What is the influence on location on biology teachers' use of cost-reducing strategies in Nigeria and The Gambia ?

Table 16

	Urban	Rural
X	47.21	40.74
N	250	250

Research Question 18

To what extent has experience influenced the biology teachers' use of laboratory management techniques in Nigeria and The Gambia ?

Table 17

	Low Experience	Average Experience	High
Experience			
X	69.80	70.08	71.11
S.D	7.64	8.76	5.83
N	175	175	150

Research Question 19

To what extent has participation in in-service training programme influenced biology teachers' use of laboratory management techniques in Nigeria and in the Gambia ?

Table 18

	Low Participation	Average Participation	High Participation
X	65.83	66.67	67.53
S.D	11.40	9.83	10.10
N	175	175	150

Research Question 20

What is the influence of qualification on biology teachers' use of laboratory management techniques in both Nigeria and The Gambia?

Table 19

	Low Qualification	Average Qualification	High Qualification
X	63.87	68.36	72.27
S.D	4.49	11.35	9.24
N	175	175	150

Research Question 21

To what extent has location influenced the use of laboratory management techniques by biology teachers in both Nigeria and The Gambia ?

Table 20

	Urban	Rural
X	84.48	72.93
S.D	5.55	9.25
N	250	250

Research Question 22

Where are cost-reducing strategies better employed, Nigeria or The Gambia

Table 21

<u>S/N</u>	<u>Item</u>	<u>X for</u>	<u>S. D. for</u>	<u>Inter. On Extent of use</u>	<u>X for</u>	<u>S.D. for the</u>	<u>Inter. On Extent of Use</u>
		<u>N/Teachers</u>	<u>N/Teachers</u>	<u>for N/Teachers</u>	<u>G/Teachers</u>	<u>G/Teachers</u>	<u>G/Teachers</u>
1.	a	2.90	1.05	moderately employed	2.59	1.21	moderately employed
2.	b	2.56	0.93	" "	2.38	1.18	sparingly employed
3.	c	2.87	0.85	" "	2.81	1.09	moderately employed
4.	d	3.44	1.00	extensively employed	3.47	0.29	extensively employed
5.	e	4.33	0.75	" "	3.62	0.83	" "
6.	f	1.59	0.60	sparingly employed	1.98	0.57	sparingly employed
7.	g	3.60	1.20	extensively employed	3.72	1.58	extensively employed
8.	h	4.11	1.06	" "	4.02	1.12	" "
9.	i	3.06	0.91	moderately employed	2.48	0.82	sparingly employed
10.	j	4.68	0.63	extensively employed	3.23	1.21	moderately employed
11.	k	1.23	0.64	not employed	1.82	0.59	sparingly employed
12.	l	3.33	1.23	moderately employed	2.63	1.32	moderately employed
13.	m	1.77	0.60	sparingly employed	1.34	0.79	not employed
14.	n	3.04	1.07	moderately employed	3.51	0.94	extensively employed
15.	o	2.02	1.32	sparingly employed	2.67	1.13	moderately employed
Overall		44.53 N = 800	7.19	moderately employed	42.27 N = 150	9.35	moderately employed

A, B, C, D, E, ... are the cost-reducing items that correspond with the key.

Research Question 23

Where are laboratory management techniques better employed, Nigeria or The Gambia ?

Table 22

<u>S/N for</u>	<u>Item</u>	<u>X for</u> <u>N/Teachers</u>	<u>Inter. On Extent of use</u> <u>for N/Teachers</u>	<u>S. D. for</u> <u>N/Teachers</u>	<u>X for</u> <u>G/Teachers</u>	<u>S.D. for the</u> <u>G/Teachers</u>	<u>Inter. On Extent of Use</u> <u>G/Teachers</u>
1.	A	4.32	efficient	0.82	3.74	0.79	efficient
2.	B	4.15	"	0.95	2.83	0.85	moderately efficient
3.	C	4.44	"	0.71	4.16	0.89	efficient
4.	D	3.21	moderately efficient	1.04	2.62	1.22	moderately efficient
5.	E	4.23	efficient	0.38	3.59	1.26	efficient
6.	F	3.79	"	0.92	3.40	1.13	moderately efficient
7.	G	4.12	"	0.59	4.78	0.85	efficient
8.	H	3.63	"	1.05	3.57	1.09	efficient
9.	I	2.94	moderately efficient	1.25	3.55	0.47	"
10.	J	1.77	weakly efficient	0.33	2.00	0.44	weakly efficient
11.	K	4.08	efficient	0.67	2.11	0.72	" "
12.	L	4.35	"	0.54	2.97	0.85	moderately efficient
13.	M	3.83	"	0.96	3.80	0.43	efficient
14.	N	4.08	"	0.83	2.11	0.56	weakly efficient
15.	O	1.65	weakly efficient	0.33	2.05	0.22	" "
16.	P	4.34	efficient	0.58	4.24	1.16	efficient
17.	Q	3.57	"	1.19	1.02	1.16	inefficient
18.	R	4.56	"	0.58	4.50	0.48	efficient
19.	S	3.51	"	1.23	4.17	0.81	"
20.	T	2.59	moderately efficient	1.37	3.22	0.49	moderately efficient
21.	U	3.41	" "	1.27	3.41	1.15	" "
22.	V	3.78	efficient	0.91	3.24	0.60	" "
23.	W	2.14	weakly efficient	0.85	2.07	0.84	weakly efficient
24.	X	4.02	efficient	0.79	4.00	0.91	efficient
		86.51	efficient	10.30	77.15	10.22	moderately efficient
		N = 800			N = 150		

A, B, C, D, E, ... are the laboratory management items that have been previously keyed.

H₀₁: No significant difference exists on the extent to which experienced Gambian and Nigerian chemistry teachers and their inexperienced counterparts employ cost-reducing strategies at 0.05 level of significance and according to their mean ratings.

The F ratio data on the experienced teachers are found below as Table 23.

Table 23

Source of Variation		Sum Squares	df	Variance Estimate	F cal	F tab	Decision
Btw Groups	Experience	1268.48	2	634.24	34.33	3.00	Significant
Within Groups	Chemistry teachers in Nigeria and the Gambia on cost-reducing strategies	8282.91	44.7	18.53			

H₀₂: Participation in in-service training programme is not a significant factor, at 0.05 level of probability in influencing chemistry teachers' ability to employ cost-reducing strategies in Nigeria and The Gambia, in accordance with their mean ratings.

The F ratio data on teachers' participation are found below

Source of Variation		Sum Squares	df	Variance Estimate	F cal	F tab	Decision
Participation in in-service		580.536	2	290.268	31.38	3.00	significant
Chemistry Teachers' participation in in-service in Nigeria and The Gambia on cost-reducing strategies		4134.79	447	9.25			

H₀₃: The significant difference between qualified and unqualified chemistry teachers in Nigeria and The Gambia at 0.05 level of probability, on the use of cost-reducing strategies, is zero according to their mean ratings.

Table 25

Source of Variation		Sum Squares	df	Variance Estimate	F cal	F tab	Decision
Qualification		870.14	2	435.07			
Chemistry teachers in Nigeria and The Gambia on cost-reducing strategies		5891.46	447	13.18	33.00	3.00	significant

H₀₄: At 0.05 level of probability there is no significant difference between chemistry teachers located in Urban schools situated in Nigeria and The Gambia and their counterparts located in rural areas, according to their mean rating.

	Urban	Rural	T cal	T tab	Decision
X	50.68	36.63	29.80	1.96	Significant
S.D.	4.02	5.70			
N	225	225			

H₀₅: At 0.05 level of significance, experience is not a significant factor influencing chemistry teachers use of laboratory management techniques in Nigeria and The Gambia and according to their mean ratings.

Table 27

Source of Variation	Sum Squares	df	Variance Estimate	F cal	F tab	Decision
Within group: Experience	987.26	2	493.63	11.33	3.00	Significant
Between group chemistry teachers in Nigeria and The Gambia on laboratory management techniques.		447	43.57			

H₀₆: At 0.05 level of significant participation in inservice training programme is not significant in influencing chemistry teachers use of laboratory management techniques in Nigeria and The Gambia in accordance with their mean ratings.

Table28

Source of Variation	Sum Squares	df	Variance Estimate	F cal	F tab	Decision
Within group: Participation in in-service	1970.27	2	984.14			
				45.26	3.00	Significant
Between 8p chemistry teachers in Nigeria and The Gambia on laboratory management techniques	9729.50	447	21.76			

H₀₇: The significant difference between the experienced chemistry teachers in the Gambia and Nigeria and their inexperienced counterparts within the same attachment is equal to zero and in accordance with their mean rating at 0.05 level of probability.

Table 29

Source of Variation	Sum Squares	df	Variance Estimate	F cal	F tab	Decision
Between group: Qualification	2167.30	2	1083.7			
				29.8	3.00	Significant
Within group: Use of laboratory management techniques by chemistry teachers both in Nigeria and The Gambia	16255.5	447	36.37			

H₀₈: At 0.05 level of significance, the mean rating in the use of laboratory management techniques by chemistry teachers in Nigeria and the Gambia who are located in urban area is not significantly different from the mean rating in the use of the same technique by their counterparts in the rural area.

Table 30

	Urban	Rural	t cal	t cable	Decision
X	85.78	72.98	18.17	1.96	Significant
S.D.	5.50	9.02			
N	225	225			

H₀₉: At 0.05 level of probability there is no significant difference between the mean ratings of experienced and inexperienced biology teachers in The Gambia and Nigeria on the use of cost-reducing strategies.

Table 31

Source of Variation	Sum Squares	df	Variance Estimate	F cal	F tab	Decision
Between group: Experience	697.9	2	348.9	2.94	3.00	
						Not Significant
Within group: Use of cost-reducing strategies by Biology teachers in Nigeria and The Gambia.	58988.9	497	118.69			

H₀₁₀: Participation in in-service training programme at 0.05 of probability is not a significant factor influencing the mean responses of biology teachers in Nigeria and The Gambia on their use of cost-reducing strategies.

Table 32

Source of Variation	Sum Squares	df	Variance Estimate	F cal	F tab	Decision
Between group: Participation in in-service	195.26	2	871.63			
				18.51	3.00	Significant
Within group: Use of cost-reducing strategies by biology teachers in Nigeria and the Gambia	23407	497	47.09			

H₀₁₁: At 0.05 level of probability qualification of biology teachers is not significant in influencing their mean ratings on the use of cost-reducing strategies in Nigeria and The Gambia.

Table 33

Source of Variation	Sum Squares	df	Variance Estimate	F cal	F tab	Decision
Between group: Qualification	2958.64	2	1479.32	30.75	3.00	Significant
Within group: biology teachers in Nigeria and The Gambia on cost-reducing strategies	23909.65	497	48.11			

H₀₁₂: At 0.05 level of significance there is no significant difference between biology teachers teaching in Nigeria and The Gambia and living in the urban area and their counterparts within the same locus but living in the rural area on their mean responses to the use of cost-reducing strategies.

Table 34

	Urban	Rural	t cal	t table	Decision
X	47.21	40.74	14.07	3.00	
S.D.	5.38	4.88			Significant
N	250	250			

H₀₁₃: At 0.05 level of significance, there is no significant difference between the mean responses of experienced and inexperienced biology teachers in Nigeria and the Gambia on their use of laboratory management techniques.

Table 35

Source of Variation	Sum Squares	df	Variance Estimate	F cal	F tab	Decision
Between group: Experience	1772.30	2	886.15			
				1.79	3.00	Not significant
Within group: biology teachers in Nigeria and the Gambia on laboratory management techniques	245985.18	497	494.94			

H₀₁₄: Participation in inservice training programme is not at 0.05 level of probability significant in determining the mean ratings of biology teachers in Nigeria and The Gambia on laboratory management techniques.

Table 36

Source of Variation	Sum Squares	df	Variance Estimate	F cal	F tab	Decision
(Between group) Participation in inservice training programme	2606.88	2	1303.44	0.91	3.00	Not significant
(Within group) Laboratory management techniques of biology teachers in Nigeria and The Gambia	711878.80	497	1432.35			

H₀₁₅: At 0.05 level of probability there is no significant difference between qualified and unqualified teachers in biology within Nigeria and The Gambia on their use of laboratory management techniques, according to their mean ratings

Table 37

Source of Variation	Sum Squares	df	Variance Estimate	F cal	F tab	Decision
(Between group) Qualified	1610.34	2	805.17			
				21.42	3.00	Significant
(Within group) biology teachers in Nigeria and The Gambia and their use of laboratory management techniques	18682.05	497	37.59			

H₀₁₆: At 0.05 level of probability there is no significant difference between Nigerian biology and chemistry teachers on the one hand and their Gambian counterparts on the other hand on the extent to which they employ cost-reducing strategies in accordance with mean rating.

Table 38

CRS	Chm. & Bio. teachers in Nigeria	Chm. & Bio. teachers in The Gambia	F cal	F tab	Decision
X	44.53	42.77	2.17	3.00	Not significant
S.D.	7.19	9.35			
N	800	150			

H₀₁₇: At 0.05 level of probability there is no significant difference between biology and chemistry teachers in Nigeria and their Gambian counterparts on their mean responses to the extent to which they have employed laboratory management techniques.

Table 39

LMT	Chm. & Bio. teachers in Nigeria	Chm. & Bio. teachers in The Gambia	F cal	F tab	Decision
X	86.51	77.15	10.29	3.00	Significant
S.D.	10.30	10.22			
N	800	150			

H₀₁₈: At 0.05 level of probability subject background is not a significant factor influencing the mean responses of Gambian and Nigerian science teachers on their use of cost-reducing strategies.

Table 40

Cost-reducing Decision Strategies	Chemistry teachers	Biology teachers	Faculculated	Ftable	
X	43.76	35.57	17.42	1.96	Significant
S.D.	7.70	6.54			
N	450	500			

H₀₁₉: At 0.05 level of probability no significant difference exists between chemistry teachers in Nigeria and The Gambia and their Biology counterparts in Nigeria and The Gambia on the extent to which they have employed laboratory management techniques according to their mean ratings.

Table 41

Lab. Mgt. Decision Tech	Chm. Teachers	Bio. Teachers	Fcalculated	Ftable	
X	81.30	67.51	17.45	1.96	Significant
S.D.	11.17	13.22			
N	450	500			

Observations

1. Research Question 1

All other items under cost-reducing strategies for chemistry teachers in Nigeria and the Gambia were either moderately or extensively employed except cost-reducing items associated with

- (i) use of substitutes when the conventional chemicals are not available for use.
- (ii) Ability to repair and maintain equipment.
- (iii) Production, marketability and profitability of products of laboratory operations and process carried out in the laboratory.
- (iv) And competency in simulating a real life experience.
- (v) Use of recycling procedure.

2. Research Question 2

The same category of teachers as in 1 above were either able to display efficiency or were moderately efficient in the use of laboratory management techniques, only exposing inefficiency in techniques associated with

- (i) insistence on the credentials of chemical suppliers before hiring their services.
- (ii) Ensuring that quantities of flammable materials do not exceed one year.
- (iii) Insistence on danger-marking, with the appropriate insignium, all reagent bottles that contain volatiles, toxic or combustible materials.
- (iv) Keeping a tag , on a regular basis, on the overall quantity of consumables as they are used up. In both research questions (1 and 2 above) chemistry teachers in Nigeria and The Gambia employed cost reducing strategies, overall, moderately and laboratory management techniques, in toto, with moderation in efficiency.

3. **Research Question 3**
While lowly experienced chemistry teachers in Nigeria and The Gambia employed cost-reducing strategies to a moderate extent, their averagely experienced and highly experienced counterparts also applied them moderately, the only difference arising in the extent of moderation, to wit: Highly experienced chemistry teachers use them better than the averagely experienced teachers who in turn use them better than the lowly experienced teachers.
4. **Research Question 4**
The same trend persists on the influence of participation in in-service training programme which for chemistry teachers with low, average and high participation in in-service training programme in Nigeria and The Gambia moderately apply cost-reducing strategies. The influence of high participation is greater than the influence of average participation which in turn is greater than the influence of low participation.
5. **Research Question 5**
Lowly qualified and averagely qualified chemistry teachers in Nigeria and The Gambia employ cost reducing strategies moderately even though the latter employ them better. The higher qualified counterparts employ them to a large extent.
6. **Research Question 6**
Urban based chemistry teachers in Nigeria and The Gambia not only apply cost reducing strategies better than their Rural based counterparts, they also employ them to a moderate extent in contradistinction to the rural based chemistry teachers who have used them sparingly.
7. **Research Question 7**
Only highly experienced chemistry teachers in Nigeria and The Gambia were efficient in the use of laboratory management techniques while lowly experienced chemistry teachers and their averagely experienced counterparts employed them moderately in efficiency of use. The averagely experienced teachers employed them more.
8. **Research Question 8**
The same trend as in 7 prevailed on the influence of participation in laboratory management techniques.
9. **Research Question 9**
8 and 9 are identical in trend and interpretation.

10. **Research Question 10**

While urban based chemistry teachers in Nigeria and The Gambia remained efficient in their use of laboratory management techniques, their rural based counterparts only remained moderately efficient.

11. **Research Question 12**

Biology teachers in Nigeria and The Gambia applied cost-reducing strategies either extensively or to a moderate extent for most of the 15 items under survey except for items that revolve around the use of the following strategies.

- (i) Use of substitutes when the conventional equipment are not available.
- (ii) Control over potential fire hazards.
- (iii) Use of small scale experiments or group experiments when the conventional materials are not within the research of each student.
- (iv) Competency at simulating a real-life-experience. In each of these four items, cost-reducing strategies are used sparingly. That notwithstanding there are situations where the biology teachers in Nigeria and The Gambia have even not bothered to employ cost-reducing strategies. They include:
 - a. Repairs and maintenance of apparatus
 - b. Use of recycling procedures
 - c. Extent to which valuable experimental products are made and stored ready for the market.

Overall, biology teachers employed cost-reducing strategies sparingly.

12. **Research Question 13**

On laboratory management techniques the same set of biology teachers as in 12 above applied the techniques with efficiency or were moderately efficient in its use except for techniques that involved the following:

- (i) insistence on the credential of suppliers before hiring their services.
- (ii) Ensuring that the qualities of flammable materials do not exceed one year
- (iii) Insistence on danger-marking volatile, toxic or combustible materials
- (iv) Keep a regular tag on the overall quantities of consumables as they are used up.

Overall, biology teachers employed the techniques moderately.

13. **Research Question 14**
Highly experienced and averagely experienced biology teachers in Nigeria and The Gambia employed cost-reducing strategies moderately with the former having an edge over the latter. The lowly experienced biology teachers employed the strategy sparingly.
15. **Research Question 15**
Only biology teachers in Nigeria and The Gambia who have benefitted highly in inservice programme participation applied cost-reducing strategies moderately. Their counterparts who have participated in the programme lowly and averagely employed the strategy sparingly, with those who have participated averagely employing the strategy better.
16. **Research Question 16**
Cost-reducing strategies were employed moderately by lowly, averagely and highly qualified biology teachers in Nigeria and The Gambia, with highly qualified biology teachers employing them best and the lowly qualified biology teachers employing them least.
17. **Research Question 17**
Both urban and rural based biology teachers in Nigeria and The Gambia employed cost-reducing strategies to a moderate extent with the urban based biology teachers employing them more.
18. **Research Question 18**
With respect to experience, all categories of biology teachers in Nigeria and The Gambia, were moderately efficient in the use of laboratory management techniques with highly experienced biology teachers being the most efficient and their lowly experienced counterparts, the least.
19. **Research Question 19**
The same trend as in 18 persists for the influence of participation in inservice training programme on the use of laboratory management techniques.
20. **Research Question 20**
The influence of qualification on biology teachers use of laboratory management techniques in The Gambia and Nigeria follows the same pattern.
21. **Research Question 21**
While urban based biology teachers in Nigeria and The Gambia employed laboratory management techniques efficiently, their rural counterparts were inefficient in the use of the same techniques.

22. **Research Question 22**

Cost-reducing strategies for chemistry and biology teachers were moderately employed in Nigeria and The Gambia but better employed in Nigeria.

While Nigeria and Gambian chemistry and biology teachers applied cost-reducing strategies either to a large or moderate extent, the following short falls are noted.

A. Nigeria

- (i) Use of recycling procedures (sparingly employed)
- (ii) Repairs and maintenance of equipment (not employed)
- (iii) Making valuable experimental products, marketing and making profit out of them (sparingly employed)
- (iv) Competency at simulating a real life situation (sparingly used).

B The Gambia

- (i) Use of substitutes when the conventional chemicals are not available (sparingly employed)
- (ii) use of recycling procedures (sparingly employed)
- (iii) ability to minimize the contamination of reagents (sparingly employed)
- (iv) repairs and maintenance of equipment (sparingly employed)
- (iv) use of stock book (not even employed)

23. **Research Question 23**

Nigerian chemistry and biology teachers were efficient in their use of laboratory management techniques. Their Gambian counterparts were moderately efficient in the use of the same technique. However, the two categories of teachers while remaining efficient or moderately efficient in the use of these techniques were inefficient in the use of the following:

Nigeria

- (i) Insistence on the credential of suppliers before hiring their services (weakly efficient)
- (ii) Ensuring that the quantities of flammable material do not exceed one year (weakly efficient)
- (iii) Ensuring that a regular tag is kept on the overall quantities of materials as they are used up (weakly efficient)

The Gambia

- (i) Insistence on the credential of suppliers before hiring their services (weakly efficient)
- (ii) Ensuring that each cupboard should bear a general label indicating the type of material it contains (weakly efficient)
- (iii) Ensuring that a regular tag is kept on the overall quantities of materials as they are used up (weakly efficient).
- (iv) Insistence on danger-labelling reagent bottles that contain volatile toxic or combustible materials (inefficient).

24. **Hypothesis 1**

At 0.05 level of probability null hypothesis H_{01} not accepted. Therefore experience significant factor on Gambian and Nigerian chemistry teachers use of cost-reducing strategies according to their mean ratings.

25. **Hypothesis 2**

At 0.05 level of significance, null hypothesis H_{02} not accepted. Therefore, participation in in-service training programme is a significant factor on Gambian and Nigerian chemistry teachers' mean responses to the use of cost-reducing strategies.

26. **Hypothesis 3**

At 0.05 level of significance, null hypothesis H_{03} not accepted. Therefore, qualification is significant in influencing Gambian and Nigerian chemistry teachers' mean responses to the use of cost-reducing strategies.

27. **Hypothesis 4**

At 0.05 level of significance, null hypothesis H_{04} not accepted. Therefore, location is a significant factor influencing Gambian and Nigerian chemistry teachers' use of cost-reducing strategies according to their mean ratings.

28. **Hypothesis 5**

At 0.05 level of probability, null hypothesis H_{05} not accepted. Therefore, experience is a significant factor influencing Gambian and Nigerian chemistry teachers' use of laboratory management techniques according to their mean ratings.

29. **Hypothesis 6**

At 0.05 level of significance, null hypothesis H_{06} is not accepted. Therefore, participation in inservice training programme is a significant factor influencing Gambian and Nigerian chemistry teachers' mean responses to laboratory management techniques.

30. **Hypothesis 7**
At 0.05 level of significance null hypothesis Ho7 not accepted. Therefore, experience is a significant factor influencing Nigerian and Gambian chemistry teachers' mean responses to laboratory management techniques.
31. **Hypothesis 8**
At 0.05 level of probability null hypothesis Ho8 not accepted. Therefore, there is a significant difference between urban based Nigerian and Gambian chemistry teachers and their rural based counterparts on the extent to which they have employed laboratory management techniques and according to their mean ratings.
32. **Hypothesis 9**
At 0.05 level of significance null hypothesis Ho9 is accepted. Therefore, experience is not a significant factor influencing the mean responses of biology teachers in Nigeria and The Gambia on the extent to which they have used cost-reducing strategies.
33. **Hypothesis 10**
At 0.05 level of significance null hypothesis is not accepted. Therefore, the mean responses of biology teachers who have participated highly in inservice training programmes are significantly different from those of their lowly inservice training participants on the use of cost-reducing strategies in Nigeria and The Gambia.
34. **Hypothesis 11**
At 0.05 level of significance null hypothesis Ho11 is not accepted. Therefore, qualification is a significant factor influencing the mean responses of biology teachers in Nigeria and The Gambia on the extent to which they have applied cost-reducing strategies.
35. **Hypothesis 12**
At 0.05 level of significant null hypothesis Ho12 is not accepted. Therefore, location is significant in influencing the mean responses of urban based biology teachers and their rural based counterparts on the extent to which they have used cost-reducing strategies in Nigeria and The Gambia.
36. **Hypothesis 13**
At 0.05 level of significance, null hypothesis Ho13 is upheld. Therefore, experience is not a significant factor influencing the mean responses of Nigerian and Gambian biology teachers on the extent to which they have applied laboratory management techniques.

37. Hypothesis 14

At 0.05 level of significance, null hypothesis Ho14 is upheld. Therefore, participation in in-service training programme is not a significant factor influencing biology teachers' mean responses to laboratory management techniques in Nigeria and The Gambia.

38. Hypothesis 15

At 0.05 level of significance, null hypothesis Ho15 is not accepted. Therefore, there is a significant difference between qualified and unqualified biology teachers in Nigeria and The Gambia on their mean responses regarding their efficiency in the use of laboratory management techniques.

39. Hypothesis 16

At 0.05 level of significance, null hypothesis Ho16 is accepted. Therefore, the significant difference between biology and chemistry teachers in Nigeria and their counterparts in The Gambia on their mean responses regarding extent in the use of cost-reducing strategies is zero.

40. Hypothesis 17

At 0.05 level of probability, null hypothesis Ho17 is not accepted. Therefore, there is a significant difference between biology and chemistry teachers in Nigeria and the same set of teachers in the Gambia on the extent to which they had demonstrated efficiency in their use of laboratory management techniques an in accordance with their mean ratings.

41. Hypothesis 18

At 0.05 level of significance, null hypothesis Ho18 is rejected. Therefore, there is a significant difference in the mean responses of chemistry teachers in Nigeria and The Gambia and biology teachers in Nigeria and The Gambia on the extent to which they had employed the use of cost-reducing strategies.

42. Hypothesis 19

At 0.05 level of significance, null hypothesis Ho19 is not accepted. The mean responses of chemistry and biology teachers in Nigeria are significantly different from the mean responses of chemistry and biology teachers in The Gambia on the extent to which they had manifested efficiency in laboratory management techniques.

Summary of Major Findings

1. On cost-reducing strategies, chemistry teachers manifested sparse use of practices associated with the

(a) ability to repair and maintain equipment

- (b) ability to market for profit the laboratory products prepared by the students themselves.
 - (c) use of recycling procedures.
 - (d) an competency in simulating a real life experience.
2. The same chemistry teachers tell short of expectations in maintaining standards on good safety practices such as providing intervention packages to the hazardous effects of fire and toxic substances.
 3. The same chemistry teachers failed to monitor the use of the quantity of materials in the laboratory.
 4. In the case of biology teachers they had acquired the short-comings of chemistry teachers enumerated above. In addition, they were deficient in accepting anybody as a supplier of biological materials without insisting on his credentials.
 5. The biology teachers are also all the more prone to flirting with the real and terrifying danger of ignoring the basic rules of fire prevention.
 6. Whether for chemistry or biology, the overall use of cost-reducing strategies or laboratory management techniques was moderate. An exception was for biology teachers in their use of cost-reducing strategies. The overall mean was sparse.
 7. The influence of experience or qualification or participation in in-service training programme or location whether on the extent to which the teachers had employed cost-reducing strategies or on how efficient they had been on the application of laboratory management technique usually followed a regular pattern: those of them who had high experience or high qualification or high participation in in-service training programme performed best while their lowly experienced/qualified/or those who participated least in in-service performed least.
 8. All in all, extent to which they had employed cost-reducing strategies or manifested efficiency for laboratory management technique was moderate irrespective of the trend referred above.
 9. Nigerian teachers, whether for biology or chemistry employed cost-reducing strategies and laboratory management techniques better than their Gambian counterparts, although both categories of teachers employed the strategies and techniques moderately.
 10. It is worthy of note that the items that informed the low use of standard practices for chemistry teachers in cost-reducing strategies and laboratory

management techniques were identical to the items that informed low use of standard practices for Nigerian teachers.

11. The Gambian teachers were deficient in the following use of the following items:
 - (a) ability to find substitutes for conventional materials.
 - (b) Use of recycling procedures.
 - (c) Repairs and maintenance of equipment.
 - (d) Ability to minimise the contamination of reagents.
 - (e) Use of stock book.
12. While the Nigerian teachers manifested efficient practice in the use of laboratory management techniques on the average, their Gambian counterparts were moderately efficient.
13. In the main, and at 0.05 level of significance participation in in-service programme or experience or qualification or location or subject area or nation was a significant factor influencing the extent to which teachers employed cost-reducing strategies or manifested efficiency in the laboratory management techniques.
14. (above) notwithstanding the following departure from the pattern should be acknowledged.
 - (a) Experience was not a significant factor influencing the mean responses of biology teachers on cost-reducing strategies.
 - (b) Experience was also not a significant factor influencing the mean responses of the same biology teachers on laboratory management techniques.
 - (c) Participation in in-service training programme was not a significant factor influencing the mean responses of biology teachers in laboratory management techniques.
 - (d) Nation was not a significant factor influencing the mean responses of biology teachers in the use of cost reducing strategies.

Chapter four

Discussion, conclusion & recommendation

This chapter embodies the discussion of the major results the conclusion and educational implications of these results to the development of science education. In addition some recommendations were made based on the findings and the limitations of the study. Lastly the summary of the entire study was presented.

Discussions of the Major Results

Extent to which chemistry and biology teachers in Nigeria and The Gambia employ cost-reducing strategies

Results indicate that chemistry and biology teachers in Nigeria and The Gambia tend to employ the following cost-reducing strategies extensively. Economizing the quantity of reagents employed during practical work; exercise of care over furnishings through effective supervision; extent of control over the possibility of glassware casualty; control over potential fire hazards and ability to involve pupils to tidy up their working space at the end of an experiment.

The extensive use of these five cost-reducing strategies is salutary. Okebukola (1994), Lorch (1997) and Colbraith (1993) suggested that since the grant-in-aid to schools was not enough, other sources of funds or productivity should be explored and tapped to the fullest by school heads who had the responsibility of ensuring that their schools survived and achieved their goals, the difficult times and constraints notwithstanding.

Each of these five strategies may be broadly classified into three headings: awareness over the consequences of wastage; destruction or breakage, prevention and possible sanction. High rating on the use of these strategies may well be a product of strict adaptation to awareness, prevention and sanction. These strategies should be endorsed as a healthy integral part of laboratory work. It not only instils in pupils a sense of discipline, it equally endows on them a sense of responsibility to the extent that they are made to accept the consequences of their action or inaction.

Finally pupils are perhaps made to appreciate that effective maintenance of furnishings, equipment and common wares is a panacea for durability and efficiency, and thus help to reduce the rate of replacement.

The cost-reducing strategies which were generally moderately employed by chemistry and biology teachers in Nigeria and The Gambia include: use of substitutes when the conventional equipment are not available; conscious application of locally available materials in spite of the presence of their conventional counterparts. Ability to quantify and record the amount of expendables committed to an experiment; use of small-scale experiments or

group experiments when the conventional materials are not within the reach of each pupil.

Use of substitutes is synonymous with improvisation which in turn is the creation or construction of cheap and simple alternatives by the teacher or his nominee and the careful selection of commonly available materials in order to make the teaching-learning process easier. It is an activity word. For the teacher it calls for a great deal of psychomotor skills and right attitudes/improvisation provides an opportunity for children to learn that science is simple, feasible to study even without a room called the laboratory. It reduces total dependence on imported materials.

Otitoji (1991) noted that less experienced teachers tended to throw up their hands in despair due to lack of equipment. He then warned that until such a time when Nigeria could manufacture all the laboratory equipment she needed or became sufficiently rich to turn her back on foreign exchange, teachers had to live with the fact that equipment shortage was inevitable.

Oladimeji (1998) enumerated situation in which scientists would need to devise suitable alternatives: e.g. when the school budget is inadequate for the purchase of scientific equipment; when the stock of scientific equipment is depleted, thereby awaiting the arrival of new stock; in an emergency situation occasioned by damage to equipment or a depletion of a particular brand of expendables; in the use of a teaching method which may not warrant the aid of a factory-made equipment or one which has to command high precision in its utility. There is therefore the need for chemistry and biology teachers in Nigeria and The Gambia to exhibit resourcefulness by improvising materials. Even the collection of these teaching materials by the pupils themselves is in itself rewarding and a stimulating learning experience.

The moderate use of locally available materials may perhaps be ascribed to the teachers' awareness that the traditional Nigeria and Gambia cultures hold a rich source of materials for developing the scientific method of inquiry and knowing about the various elements and processes of the Nigerian and The Gambian environments. Granted that the present state of scientific knowledge within the Nigerian and Gambian contexts may be intuitive or rudimentary or sometimes even contrary to modern scientific knowledge, the infrastructures according to Ikoku (1991) and Okwu (1991) with specific reference to Nigeria, are there.

The Nigerian and Gambian children must therefore be made aware of the scientific and learning potential in their rich environments. Vital questions that are being asked include: what local materials are being used? What locally available materials should be suitable for the teaching and how do they relate to the curriculum? What learning experiences are feasible with such materials? What cost advantages accrue from using such materials ?

Unfortunately, the teaching of chemistry and biology in Nigeria and The Gambia is too academic and dictated by the rather stereotyped external examination. The secondary school chemistry and biology courses should therefore be developed in order to incorporate the relevance of chemistry and biology to everyday life. However, a locally based attempt to improvise may be successful if it is fine-tuned to compete successfully with established commercial manufacturers in the four key areas of design, price, quality and ease of procurement. In this respect, Ogunniy (1998) cautioned that a local material should not be misconstrued for a low quality product. Thus, in designing a locally-based product, a balance must be struck between sophistication and simplification. Too much emphasis on the former will result in items which are too expensive to make; too much emphasis on the latter will result in bad products with its concomitant consumer-resistance. 'Minimising the contamination of reagents' was moderately employed by chemistry and biology teachers. Contamination should be avoided because once a reagent is contaminated, it loses its original identity and thus becomes unreliable as a test reagent a liability and a waste. Once it is discarded, it imposes an extra-financial burden on the user body because it must be replenished with money.

Chemistry and biology teachers also endorsed "moderate use" to the ability to quantify and record the amount of expendables committed to an experiment. Perhaps their moderate use of this particular strategy might have been informed by their moderately efficient disposition to the use of damages and breakages book and to their efficient application of the stock book. The stock book contains the quantity of all apparatus received, their names and dates of purchase. By means of an inventory a tag is kept on all in-coming and out-going materials. Thus, it becomes possible to compare the rate at which materials are consumed with the rate at which they are replaced. By implication, a deliberate check can therefore be imposed on expendables if the rate of consumption outweighs the rate of replacement. This posture is cost-reducing.

The chemistry and biology teachers in The Gambia and Nigeria also endorsed a moderate use of small-scale experiments when the conventional materials were not within the reach of each pupil. Use of small scale experiment is an effective integral part of cost-reduction. Put rather succinctly the quantity of material employed by a pupil for a macro-experiment could be equivalent to the amount employed by at least ten pupils in a micro-experiment. What is more, the quality of the two experimental results remains comparable. However, the degree of sophistication needed for a semi-micro approach would appear to invite a corresponding degree of maturity and responsibility on the part of secondary school pupils.

Cost-reducing strategies which were sparingly employed by chemistry and biology teachers in Nigeria and The Gambia, in the main include:

- (a) use of substitutes when the conventional chemical are not found;
- (b) extent to which valuable experimental products such as soap are made and stored; ready for the market;
- (c) use of recycling of procedures
- (d) repairs and maintenance of equipment and
- (e) competence at simulating a real-life situation.

The chemistry and biology teachers' use of (a) above particularly for chemistry teachers is sparse. This is unfortunate. Without them, experimental work is null and void. Chemicals are the soul of laboratory operations, particularly in chemistry. Their non-use as substitutes becomes all the more worrying because of their expendable nature i.e. they are flushed down the drain at the end of an experiment and therefore are hardly recovered. The low response rating might very well be as a dearth of literature materials on methods of preparing them from cheap and available materials.

As a cost-reducing strategy "the extent to which valuable experimental products are made and stored ready for the market" was sparingly employed. There is no doubt that the visible and tactile experiences acquired in the process of practically converting a raw material into a finished product or of monitoring the seemingly imperceptible rise of a process from a minuscule to maturation, are more rewarding than the verbal descriptions and explanations preceding the actualization of such operations. Unfortunately, the word "production" threatens teachers' professional stability and exposes rather adversely their dependence on theoretical exposition. What must be made obvious to these teachers is that as they acquire knowledge and skills such knowledge and skills are a form of capital which in turn is a product of deliberate investment. The growth of that investment may well be the most distinctive feature of cost-reduction. However, if chemistry and biology teaching have to be cash-productive, the venture has to be self supporting, the teachers must be versed in production techniques, the venture must determine the range of products it wishes to manufacture, the curriculum must be flexible, the pupils must be motivated, the authorities must bless the venture, a good market strategy must be enunciated involving a ready market, the products must fairly withstand a competitive strain and most importantly, the venture must be profit-oriented. Finally for the programme to succeed, the proceeds must be ploughed back to support the laboratory.

The application of recycling procedure as a cost-reducing strategy was also sparse. Recycling, in this context, is a process whereby a waste product is passed through a series of changes or treatment for purposes of reconverting it into a useful product or in the alternative, reclaim part of the original material. One is not surprised at the low status accorded to this relatively new aspect of laboratory work. World-wide it has not really attracted considerable attention from chemists and biologists, but it stands out, if fully tapped, as the best modern mitigator to the present economic glut. Thirty years ago, when science teachers were complacently snuggled in the warmth of relative abundance, all waste

materials were regarded as terminal, nauseating, and at best illustrative of a concept. Today, recycling has become an economic necessity. Today various chemical and biological processes have served as a leverage for various recovery processes. It is hoped that all biology and chemistry teachers will take advantage of the potentials implicit in recovery processes.

Repairs and Maintenance of Equipment

This aspect of cost-reducing strategy was lowly rated. This ineptitude on the part of chemistry and biology teachers in Nigeria and The Gambia has not come to anyone as a surprise. It is highly improbable for teachers who do not even own a quick fit or a microscope to know how to maintain one, let alone, repair it. Maintenance of equipment is considered a function of cost-reducing because it prevents an equipment from breaking down completely thereby obviating the imposition of an extra-financial burden on the institution considered. Today, our laboratory stores have been converted into junks. Skeletons of outdated burners, derelict weighing balances and over-used microscopes stick out of termite riddled shelves and cartons. Some have been discarded for faults as minor as off-centre displacement in balances leaks through burette rubber tubes and a stiffened air-hold adjuster in a Bunsen burner.

Cost-reducing strategies based on competency at simulating a real-life situation was also sparingly employed. Simulation is suggestive of a counterfeit where replicas or representations are made of apparatus for demonstrations or for the analysis of a problem. Simulation may be appropriately described as an integral part of improvisation. It dwells extensively on the teachers' imaginative and inventive skill. Perhaps this may have been what Bomide (1985) referred to as a model drawing representing reality in contrast to the actual construction of the required apparatus. Unfortunately chemistry and biology teachers in Nigeria and The Gambia have confessed their inability to take advantage of this technique.

Efficiency of Chemistry and Biology Teachers in Nigeria and in The Gambia on the use of Laboratory Management Techniques

Chemistry and biology teachers were quite efficient in considering catalogue prices from different companies before making a purchase. It is important to relate the cost of an equipment to its quality. This is probably why it is necessary to compare catalogue prices from different companies before making a purchase. What happens next is a matter of choice. Otuka (1999) suggested that after the initial market survey, the department should eventually select from one firm, as this might be eligible to discount. The other reason, of course, was that standard items were cheaper when purchased in bulk. This view has an inherent problem. Bulk purchase from one firm stands the danger of an adverse mix-up of good items, not-so-good items and bad items. If the not-so-good items are significantly manifested within the hybrid, then there is difficulty, the discount notwithstanding. If on the other hand, the best based on cheapness, quality and strength, are drawn from firms which have them, the overall cost in this regard may not be

appreciably different from the former, provided model and design are de-emphasised.

Chemistry and biology teachers were efficient in the use of skills that are associated with "completion of items to be purchased with a catalogue that has not become obsolete". It is therefore bad practice to complete a list of items for order with an old catalogue. Model, design and quality enjoy an update over a period of time. Thus items reflected in an 1989 Fisher Catalogue would have become anachronistic ten years after that. In addition, given the present dispensation of run-away inflation, experience has shown that increase in the cost of science materials per annum is between 20% and 25%.

"Priority placement of items considered indispensable before making an order" was highly rated by chemistry and biology teachers. Common-sense dictates that schools/departments should reconcile what is to be purchased with the demand for it, which in turn is influenced by the diminishing returns, urgency, possible alternatives and ease of procurement. Attention is hereby drawn to some anti-laboratory management practises whereby some laboratories embark on the purchase of highly expensive and sophisticated materials irrelevant to the pursuit of learning at the particular pedagogic level. It is ironical that the same laboratories cry out when they do not have the relatively cheaper materials which they would have applied with relative ease in addressing the same class level on the same discourse. The expensive ones are show-cased in their splendour as they continue to snuggle peacefully in paper jackets.

Chemistry and biology teachers are proficient in the use of stock book. The stock book is to a teacher what a map is to a path-finder. It contains all apparatus and other laboratory materials received, date of receipts, quantity received and quantity expended. Therefore, when it becomes necessary to order a fresh supply of materials reference to a well kept stock book can save a great deal of time and money.

"Delivery note accompanying an order is identical with the items ordered" and "the correct numbers ordered have arrived". This aspect of laboratory management technique has been efficiently handled by chemistry and biology teachers in Nigeria and The Gambia. It is a big relief to note that respondents are efficient in this regard. With the arrival of a new order, the teacher should not take anything for granted. A misjudgement in either the use of the delivery note or in counting the materials correctly could place the laboratory in a serious financial position, especially at this period when, according to Ademyi (1991) the materials for teaching chemistry have dwindled considerably.

Chemistry and biology teachers are also efficient in ensuring that reagent bottles are labelled. Unlabelled or improperly labelled reagent bottles may have a devastating effect on practical exercises and when pupils are misled, no valid results are obtained. An unlabelled bottle may turn out to contain a highly volatile

liquid. If it is inadvertently applied to a naked flame, the loss accruing to this in terms of material and possibly human resources could be inestimable. Chemistry and biology teachers were quite efficient in applying the technique that ensures that planned safety measures are adopted to prevent injury to persons and equipment. When an equipment is damaged, it imposes an extra cost on the institution if it must be replaced. Chemistry and biology teachers, it would appear, are mindful of a set of acts of omission or commission which are likely to lead to the damage of equipment; and as Pritchard (1990) would enumerate them, they consist of the following: inadequate supply of fire fighting equipment; inability to relay distress signals promptly through alarm bells and telephones; ignorance over the correct use of chemicals or equipment; ignorance in selecting the right equipment or material for the right job at hand; clumsiness and wrong skills using the right equipment; carelessness, laziness, ineptitude; inability in deciphering the limitations of equipment or material, poor maintenance of equipment; poor and cramped up working space, inability to carry out proper scrutiny of the equipment and material under consideration before subjecting them to use; poor ventilation and overloading in case of machines.

Laboratory management techniques in which chemistry and biology teachers were moderately efficient are as follows:

Use of damages and breakages book; ensuring that equipment are in full working conditions; ensuring that the equipment are functionally and structurally correct as ordered before acceptance; ensuring that each piece of equipment is kept in a specific place; ensuring that each cupboard should bear a general label indicating the type of material it contains; ensuring that suitably sized drawers are provided for the storage of glassware; ensuring that beakers are stored individually and not in nests; ensuring that chemical that react with each other are not stored together; ensuring that chemicals that are susceptible to photo chemical disintegration are stored in coloured bottles.

Chemistry and biology teachers rated the use of damages and breakages book moderately. Damages and breakages book helps to account for lost apparatus in the laboratory. It should consist of name and apparatus broken; name of the defaulter even if he is the teacher; cause of damage; judgement; signature of defaulter date of replacement where applicable and teachers' counter signature. It is necessary that any wilful damage must attract immediate sanction for two reasons; it serves as a deterrence to others. It also arrests the undue depletion of materials.

All the other laboratory management techniques in which chemistry and biology teachers were moderately efficient are specifically associated with storage. They are as follows: ensuring that each equipment is kept in a specific place; ensuring that each cupboard should bear a general label indicating the type of material it contains; providing for suitably-sized drawers for the storage of glassware; ensuring that beakers are stored individually and not in nests; ensuring that

chemicals that react with each other are not stored together; and ensuring that chemicals that are susceptible to photochemical disintegration are stored in coloured bottle.

If equipment are mixed up indiscriminatory in an unlabelled cupboard, it will take much longer to identify a particular equipment being sought for. In addition, other equipment may get damaged in the grope-in-the-dark process.

Drawers that are too small tend to leave glassware in a cramped-up position creating an internal tension and an avenue for breakage. On the other hand, drawers that hold equipment loosely may, at the slightest tremor, unleash a horizontal rolling effect whose ripple will cause glass ware to bang against glassware, resulting in breakage.

Once two chemical that have an affinity for each other are allowed to exist in a contiguous arrangement, there is the possibility that they may form a new compound, the implication being that the original characteristics of the contents of the two bottles are lost. This constitutes a waste. Even then, the incipient new compound could lead to an explosion or to any other potential hazardous substance.

In the case of a substance susceptible to photo-chemical disintegration, a new substance may again be formed unless the material is stored in a opaque-like coloured bottle impregnable to light.

Laboratory management techniques in which chemistry and biology teachers were generally inefficient are as follows: use of accident and first-aid book; insisting on the credentials of suppliers before hiring their services; ensuring that the quantities of flammable materials do not exceed one year; insisting that reagent bottles that contain volatile, toxic or combustible materials are danger-marked with the appropriate insignium and finally ensuring that a regular tag is kept on the overall quantity of all consumables as they are used up.

They were inefficient in the use of accidents and first-aid books. Considering the ever growing sophistication implicit in teaching chemistry and biology and a new generation of students, some of who now enter secondary schools at the age of ten and leave at fifteen, it has become necessary to document, in the event of future occurrence, all accidents, minor and grave, that have occupied in the laboratory, and the corresponding first-aid administered in each case. Documentation of accidents in an accident book will guide the teacher to prevent the occurrence of another accident from source. In the case of first-aid, a first aid book is necessary. Recorded treatment committed to memory is better than one in which the teacher is battling with both the text-book instructions for first-aid and its administration. The first-aid and accident book reflects the view that most accidents are better described as incidents which could be prevented by adequate fore-thought.

Chemistry and biology teachers are also inefficient in the use of laboratory management techniques that deal with the insistence on seeing the credentials of suppliers of laboratory materials before hiring their services. It is necessary that teachers exhibit caution in dealing with anybody who claims to be a supplier of items for the chemical industry. These days, patent medicine dealers, all purpose contractors, zoo keepers and even retired sanitary inspectors are in the race, talking you into accepting Ammonium Chloride for Aluminium bromide.

The science teachers in both countries were also inefficient in ensuring that the quantity of flammable materials would not exceed one year. Flammable materials stored for too long may create leaks in their containers, usually of metals. In that free state they become potentially dangerous. Leaks in phosphorus and sodium are known to have caused a conflagration of inestimable destruction.

So did the same category of teachers assign low response to the danger-making of reagent bottles containing hazardous substances. Volatile and combustible materials are potential sources of fire hazards while toxic material may enter the system via inhalation, through open wounds by absorption or by ingestion. It behoves chemistry and biology teachers in both countries to sensitize their pupils to the dangers inherent in these materials. Skull label for poisons, flame tag for combustible or volatile materials and where non of these is available, a simple mark of "red" to indicate danger in general. These silent appealers are preventive measures.

Biology and chemistry teachers were inefficient in "ensuring that a regular tag is kept on the overall quantity of consumables as they are used up". These science teachers should be able to quantify and record the amount of consumables committed to an experiment. It seems fair to argue that unless a regular tag is maintained, chemistry and biology teachers may be oblivious of the extent to which their consumables have been depleted. This may create problems when items are about to be ordered, and in most cases some items may be omitted completely in the order placement list.

More embarrassing is a situation where consumables got completely exhausted even when the need for them is most imminent. It seems fair to suggest that the amount of expendables consumed and its corresponding residual amount left, be itemized on a weekly basis through the proper use of a stock book, damages and breakages book and accident/first aid book.

Influence of experience, in-service training programme, qualification, location on chemistry and biology teachers in Nigeria and The Gambia on use of :

- (1) cost-reducing strategies
- (2) laboratory management techniques.

The trend remained predictable, with extent of use of cost-reducing strategies or efficiency in the use of laboratory management techniques increasing with increase in the magnitude of the variable garnered. In the case of location, urban based teachers made better use of these strategies and techniques better than their rural based counterparts.

This is hardly surprising. Human resource conditions have to be adequately provided if meaningful cost-reducing strategies have to be embarked upon. Obviously highly experienced or highly qualified chemistry and biology teachers are expected to provide the most needed cutting edge to cost-reducing strategies.

In the case of participation in in-service training programmes, the trend obtained is hardly surprising. Firstly, five of the ten in-service themes employed for the purpose of classification into low, average and high participation in programmes that have been organised overtime, have a cost-reducing implication. Thus chemistry and biology teachers who had been involved in in-service training programmes associated with repairs and maintenance of equipment, improvisation, motivating students through the use of small-scale experiments; use of local resources and commercializing the products of laboratory operation among others, are likely to be classified as "Teachers who have participated highly in in-service training programmes" and ipso facto are likely to use cost-reducing strategies effectively. Secondly, the quantity and extent of good chemistry and biology teaching will always depend on the extent the teacher is helped to improve his skill, knowledge and competence along innovative lines based essentially on modern teaching techniques.

While teachers with high experience were efficient in their use of laboratory management techniques, their counterparts with average and low experience were moderately efficient. Highly experienced teachers are expected to be efficient in the four main areas of laboratory management and organisation, namely: ordering, stocking, storage and safety. The instinctive application of laboratory management techniques would appear to have been acquired as a result of many years of experience, the influences of other variables notwithstanding. However, what is common-sense or normal to the highly experienced teachers may well be outside the range of "normal" experience for the other less experienced teachers especially the lowly experienced ones, hence the trend.

Whereas chemistry and biology teachers in The Gambia and in Nigeria with high participation in in-service remained efficient in laboratory management techniques, those of them with average and low participation were moderately efficient in the use of the same technique. Again, five of the ten themes employed for purposes of classification into low, average and high participation in in-service training programme which have been organised over the years have a laboratory management orientation. They are as follows: effective utilization of

materials, organization and management of laboratories and motivating students through small-scale experiments. If these techniques partially determined the magnitude of rating on participation, then their influence on the efficiency of laboratory management techniques appears valid. Thus participation would appear to be a function of technique. Furthermore, the quality of laboratory management techniques is functionally related to a well organised curriculum development set-up for chemistry and biology teachers replicated in defined periods for the acquisition of skills and competence on ordering,, stocking, storage and safety of equipment.

Whether for cost-reducing strategies or laboratory management techniques, urban-based chemistry and biology teachers in Nigeria and The Gambia were more efficient than their counterparts in the rural areas. This finding would appear to lend credence to the often asserted belief that a conducive environment is a function of efficiency. There are accepted indices on which the conferment of an urban status depends. Their include, among others, a good network of usable roads, a dependable shelter-oriented programme, provision of a workable primary and secondary health establishment, reliable security assurance put in place, affordable and value-oriented educational institutions, hiccup-free water and electricity facilities and the general upliftment of luxury standards. In rural areas these conditions that improve the conditions of life and living and add to the nuances of comfort and motivation are generally not in place.

Even the allocation of science materials and the distribution of teachers to colleges are largely influenced by locations that are imbued by the aforementioned facilities. Chances are that urban areas predominantly will attract science facilities and their highly motivated human resources. It is known that in some cases, teachers are punitively relocated to rural areas as a form of sanction. No wonder then that urban-based chemistry and biology teacher in Nigeria and The Gambia apply cost-reducing strategies to a larger extent and laboratory management techniques more efficiently than their rural counterparts. In some cases, the difference is significant.

Generally, chemistry teachers apply both cost-reducing strategies and laboratory management techniques more extensively and more efficiently than their biology counterparts. In some cases, the difference is significant. Chemistry like biology is a subject that deals with hands-on activities. In the case of chemistry, the teachers are exposed more to a variety and a more variegated form of laboratory management and organisation, reducible into finer rivulets of practical exercise such as ordering, delivery, stocking, storing, safety, first aid, manipulative skills, improvisations, recycling, mathematical skills etc and further reduced into minuscule. The materials for chemistry have a more involved scope, require softer handling, are far more dangerous to handle and are more expensive.

Nigerian chemistry and biology teachers are more effective both in the use of cost-reducing strategies and laboratory management techniques. Granted that both categories of teachers derived their education in the colonial days from Europe and the United States of America, it is no secret that the proliferation of Universities, polytechnics and colleges of Education in Nigeria (at a time when the Gambia did not have a university, when it had one college of education and one polytechnic) would have been responsible for the finding. When the Gambia had its first university in 2000, Nigeria has over 40, the first being in 1948.

Education Implications of the Findings

Compared with their counterparts with average and low experience on the one hand and average and low qualification on the other hand, chemistry and biology teachers in Nigeria and The Gambia with high experience and high qualification not only participated extensively in the use of cost-reducing strategies, they also applied themselves efficiently in the use of laboratory management techniques.

Similarly, chemistry and biology teachers who had participated highly in in-services training programmes not only employed the use of cost-reducing strategies better than their average and lower counterparts in that order, they also demonstrated proven efficiency on laboratory management techniques better than their counterparts in the same order. So did urban located biology and chemistry teachers.

Implicit in and derivable from this is that chemistry and biology teachers could enrich their use of cost-reducing strategies and laboratory management techniques by acquiring the necessary qualification and experience. Furthermore, the more these teachers take advantage of organized in-service training programme, the more they are likely to acquire greater skills competence and proficiencies in the use of cost-reducing strategies and laboratory management techniques. Finally education planners should attempt to address the facility in balance between rural and urban based school which for now appears to tilt heavily in favour of the latter.

Recommendations

Of the deficiencies that were earlier on enumerated lowly qualified and inexperienced teachers with low participation in in-service training programmes were inclined more to deficiencies. College administrators should therefore ensure that pre-service training programmes are organised for biology and chemistry teachers with low experience while efforts are made to ensure that they update their qualifications. Other categories of teachers, whether qualified/experienced or not, should be made to attend regular workshops based on effective laboratory techniques and safety measures. Extensive use should be made of teachers' guides and printed aids which can provide important background information and hints on cost-reducing strategies and laboratory management techniques. These workshops should not be stereotyped. They should be resilient to the point of including in the schedule periodic seminars to

survey curriculum and to suggest changes and adaptations to suit local setting. If science educators should emphasize cheaper but adequate experimental designs, simple but correct laboratory techniques, they must insist that the extensive use of the former and the efficient application of the latter should become the product of qualification and experience and the readiness to update professional expertise through organised preserve and in-service training programmes replicated in a predictable manner. More attention should be paid to rural-based schools in terms of supplying them with sufficient human and material resources and by making the conditions that make for comfort and leisure increasingly ameliorative.

Biology teachers must elasticise the scope of laboratory practice and operations to extend beyond the purview of manipulative skills, ordering, stocking, storage and safety.

As for teachers in The Gambia, an attractive remunerative package should be recommended along with other inducements to arrest the turn-over of teachers to other sectors of the economy and to attract high level man power to the teaching profession. In addition to all these, a faculty of Education should be established at the incipient. University of The Gambia where hopefully laboratory skills imbued with cost-reducing strategies and laboratory management techniques could be actualised.

Suggestion for Further Research Work

Development of a list of cost-reducing strategies and laboratory management for the evaluation of the teaching of integrated science to junior secondary students in Nigeria and The Gambia.

Limitations of the study

1. The collection of data from a wide range of respondents in Nigeria and The Gambia was not only time and energy consuming, but also judging by the small amount of money doled out for so large a project, was also financially sapping.
2. The financial support from the sponsoring body did not come in as and when due. This lapse was not correspondingly made up for by an anticipated extension of the closing state. The researchers were therefore consigned to a shorter time-frame with its resultant crush.
3. Due to some logistic problems it was not possible to get to all the respondents.
4. There were traces of collusion among the respondents.

5. In spite of the apparent high educational level of the respondents, there was good evidence to suggest that a fraction of the respondents did not quite understand some of the items in the questionnaire.

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