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Assessment of Secondary School Chemistry Teachers' Quality through Identification and Use of Laboratory Apparatus in Cross River State, Nigeria

IBE, JAMES ODUM (Ph.D)

ADAH, STEPHEN AKOMAYE (Ph.D)

IHEJIAMAIZU, CHRISTIANA CHINYERE (Ph.D)

DEPARTMENT OF CURRICULUM AND INSTRUCTIONAL TECHNOLOGY
FACULTY OF EDUCATION
CROSS RIVER UNIVERSITY OF TECHNOLOGY
CALABAR

Abstract
This paper assessed secondary school chemistry teachers' quality with respect to identification and use of seventy-one (71) laboratory pieces of apparatus. Four hundred and fifty-four (454) teachers purposively selected from the three educational zones in Cross River State was the main study sample. An instrument titled Laboratory Apparatus Identification and Use Questionnaire (LAIUQ) was used to gather data from the subjects. By using simple percentage and independent t-test to analyze the data, results revealed that 354 (78.0%) of the teachers could not identify (through writing of names and uses) 60 (84.50%) of the commonly used pieces of laboratory apparatus. Gender and school location of teachers exerted significant influence on their level of identification and uses of laboratory apparatus. Based on the results, recommendations aimed at strengthening teachers' competencies in laboratory usage were made among which was that state and local governments should organize re-training workshops to acquaint them with laboratory apparatus and their uses.
Key words: Assessment, Teacher Quality, Laboratory Apparatus.

Introduction

The study of chemistry as a science subject in senior secondary schools entails the exposure of learners to both theoretical and practical aspects of learning experiences. Njoku (2003) opined that chemistry is practical-oriented and the interest of learners in the chemistry practical activities is indispensable for their mastery of the subject. It aimed at enabling the learners acquire science process skills needed for proficiency in scientific enterprise. Practical exercises are normally conducted in a laboratory using pieces of apparatus and chemical reagents (Ojukuku, 2012). Laboratory experiences are so important that the examination bodies like West African Examinations Council (WAEC) and National Examination Council (NECO) assessed learners' competency as part of the final year examination in senior secondary. For instance, part of the questions in WAEC Chemistry 3 practical (2007 and 2009) were:

- List four pieces of apparatus that would be used in determination of heat of neutralization, and
- List three pieces of apparatus required for evaporation of sodium chloride solution to dryness.

Reports from WAEC Chief Examiners (2008, 2009 and 2010), revealed that candidates responses have not been encouraging. It depicts lack of acquisition of the required skills which may stem from inadequate exposure of learners to the uses of laboratory apparatus. It is an indication that something is still wrong in secondary school chemistry which calls for investigation and remediation.

The continuous records of students' poor performance has attracted a lot of assertions (Nwagbo, 2002 & Njoku, 2005). Nwosu (2003) had pointed out that the teacher is an important determinant of the quantity of learning by the learner. Eze and Njoku (2011) opined that teachers are the pivot of the education system and therefore they are at the centre of any reform effort in the system. According to Ikeobi (2010), it is the teacher who organizes the interactions between the subject (learner) and the object (learning materials). It is the teacher who ensures that equipment and materials are properly used by the learner to achieve the expected objectives. All these points to the fact that the teacher is a very significant factor when the learners failed to exhibit the expected mastery in a science subject like chemistry. Okebukola's (1985) in Njoku (2007), research on factors

that affect students' performance in practical chemistry listed among others teacher's attitude to chemistry laboratory work. Equally, Njoku (2007) attributed students descending differential achievement of chemistry students in three categories of quantitative analysis, qualitative and theory of practical questions to wrong way and manner teachers teach practical chemistry.

Efforts have been made in enhancing chemistry teachers' level of competency in effective execution of laboratory activities with the learners in senior secondary schools (Njoku, 2003 & Kaufman, 2010). These attempts however, are yet to determine teachers' mastery in identification of pieces of apparatus and their uses in chemistry laboratory. Where teachers problem areas are overtly and properly delineated effective solution can be proffered as no educational system can rise above the level of competence of the teachers.

Purpose of the Study

The purpose of this study was to determine chemistry teachers' level of competence in laboratory activities through writing names and uses of common pieces of laboratory apparatus and the extent to which this is influenced by gender and location of the teachers.

Research Questions

The study was guided by the following research questions:

1. To what extent do chemistry teachers identify through writing of names and uses commonly use laboratory apparatus?
2. To what extent does gender of chemistry teachers influence their level of competence in identification of commonly use laboratory apparatus?
3. To what extent does location of chemistry teachers influence their level of competence in identification of commonly use laboratory apparatus?

Hypotheses

1. Chemistry teachers competency level in identification of commonly used laboratory apparatus is low.
2. Gender has no significant effect on chemistry teachers' mean achievement in identification of commonly used laboratory apparatus.
3. Location of teachers has no significant effect on their mean achievement in identification of commonly used laboratory apparatus.

Methodology

The study employed a survey research design. The population of the study consists of all chemistry teachers in both public and private schools in Cross River State. A purposive sampling technique was used to constitute a sample of 454 (300 male and 154 female) chemistry teachers from 227 schools who participated in the State Ministry of Education retraining workshops for science teachers held in the three educational zones (Calabar, Ikom and Ogoja) in 2010 and 2012.

Instrumentation

The instrument for data collection was a questionnaire titled Laboratory Apparatus Identification and Uses Questionnaire (LAIUQ) which has two sections. Section A consists of issues of respondent's bio-data and identification. Section B is a list numbered from 1 to 71 for the respondents to write the name and uses of a piece of apparatus that had the number tag. It was validated by the researchers in conjunction with other senior colleagues in the Science education department.

Procedure for Administration of Instrument

The respondents as participants in a workshop for the improvement of senior school certificate examination science practicals were presented with pieces of laboratory apparatus number 1 to 71. Each respondent was issued with a copy of the questionnaire and requested to independently write the name and uses of each piece of apparatus in the questionnaire. This was retrieved after one hour, marked and graded over 100 for discussion. The researchers supervised the sessions as facilitators during the workshop.

Data Analysis

The statistical tools used for data analysis were simple percentage and independent t-test.

Results

Table 1: Percentage of Chemistry Teachers with Correct Name and Uses of a Piece of Apparatus N = 454

S/N	Name of Apparatus	Number of Teachers with Correct Name and Uses	Percentage
1	Crystallizing dish/basin	182	40
2	Evaporating dish/basin	173	38
3	Beaker	218	48
4	Bell jar	113	25
5	Gas jar	182	40
6	Beehive shelf/Gas jar stand	91	20
7	Reagent bottle	431	95*
8	Dropping bottle	159	35
9	Sample bottle	136	30
10	Wash bottle	218	48
11	Woulff's bottle	113	25
12	Aspirator bottle	177	39
13	Brushes	341	75*
14	Bunsen burner	363	80*
15	Burette	363	80*
16	Chromatographic tank	60	15
17	Clip (mohr) crocodile	91	20
18	Combustion tube	136	30
19	Condenser Liebig	159	35
20	Corks	318	70*
21	Cork ring	295	65*
22	Crucible	113	25
23	Tong crucible	136	30
24	Desiccators	159	35
25	Drying (absorption) tube	91	20
26	Drying tower	136	30
27	Distillation column fractional	145	32
28	Conical flask	363	80*
29	Flat-bottomed flask	341	75*
30	Round-bottom flask	327	72*
31	Filtering flask (buchner)	113	25
32	Distillation flask	218	48
33	Volumetric (standard) flask	173	38
34	Retort flask	136	30
35	Filter funnel	386	85*
36	Separating funnel	127	28
37	Thistle funnel	109	24
38	Gipp's apparatus (Gas generator)	91	20
39	Wire gauze	363	80*
40	Measuring cylinder	173	38
41	Mortar and pestle	159	35
42	Bulb (transfer) pipette	113	25
43	Dropping pipette	136	30
44	Graduated pipette	145	32
45	Rod glass (stirrer)	136	30
46	Sample (specimen) tube	113	25
47	Scissors	204	45
48	Spatula	191	42
49	Syringe	182	40
50	Deflagrating spoon	91	20
51	Retort stand	173	38
52	Clamp	159	35

53	Retort stand with ring	136	30
54	Burette stand	145	32
55	Tripod stand	218	48
56	Pipette stand	113	25
57	Test tube	222	49
58	Test tube holder	218	48
59	Test tube stand (rack)	209	46
60	Thermometer	177	39
61	Centrifuge	113	25
62	Tube delivery	204	45
63	Tile (white)	204	45
64	Triangular pipe-clay	173	38
65	Trough pneumatic	91	20
66	Petri dish	91	20
67	Water (steam) bath	113	25
68	Watch glass	173	38
69	Stop-watch	159	35
70	Voltameter Hofmann's H-type	91	20
71	Weighing Balance	113	25

* Pieces of apparatus identified by 50% and above of the teachers.

From Table 1, eleven of the seventy-one pieces of apparatus were identified by 50% and above of the respondents, fourteen by 40 to 49% of the teachers, forty-five by 20 to 29% of the teachers and one by 15%. This means majority 60 (or 84.50%) of the seventy-one pieces of the commonly used laboratory apparatus were not effectively and correctly identified by the chemistry teachers. It implies low level of competency of the chemistry teachers in identification of laboratory apparatus and hence inadequate acquisition and possession of skills in organizing practical chemistry at the senior school level of education. This tends to confirm Achimugu's (2012) assertion that many chemistry teachers do not bother how they conduct chemistry practical in the laboratory and that in most schools it is done haphazardly. If teachers cannot adequately write the names and uses of apparatus they are expected to work with, then they would find it difficult and probably impossible to organize chemistry practicals in the schools they teach.

Table 2: Mean, Standard Deviation and Standard Error Mean of Male and Female Teachers' Achievement in Identification of Laboratory Apparatus

	Group	N	Mean	Std. Deviation	Std. Error Mean
Sex	Male	300	53.0567	13.82306	0.79807
	Female	154	43.9545	14.64050	1.17977
	Total	**545**	**48.5056**	**14.23178**	

Table 2 indicates that male teachers have a mean of 53.0567 and standard deviation of 13.82, while the females have a mean of 43.954 and standard deviation of 14.64050. This shows that the male teachers perform better than the female teachers in the identification of laboratory apparatus. Table 2 equally reveals 48.5056 as the overall mean achievement of the chemistry teachers in identification of laboratory apparatus. This is less than 50 which has been conventionally regarded as pass mark-for assessment of cognitive achievement.

Table 3: Two-tailed t-test difference between mean achievement of male and female teachers in identification of laboratory apparatus

		Levene's test for Equality of Variance		t-test for Equality of Means		
		F	Sig.	t	df	Sig (2-tailed)
Sex	Equal variances assumed	.048	.827	6.510	452	.000
	Equal variances not assumed			6.390	293.607	.000

Table 3 reveals that there is a significant difference at 0.05 between male and female teachers' mean achievement in identification of laboratory apparatus. This is because the 2-tailed level of significance is 0.000 which is less than 0.05. Therefore, the null hypothesis is rejected. It means gender has significant effect on teachers' ability in identifying commonly used laboratory apparatus.

Table 4: Mean, Standard Deviation and Standard Error Mean of Rural and Urban Schools Chemistry Teachers in Identification of Laboratory Apparatus

	Group	N	Mean	Std. Deviation	Std. Error Mean
Location	Urban	227	51.9163	14.35045	.95247
	Rural	227	48.0044	14.54669	.96550
	Total	**454**	**49.9604**	**14.44857**	

Table 4 shows that teachers in urban schools recorded a mean of 51.9163 and standard deviation of 14.35, while teachers from schools located in rural areas recorded mean of 48.0044 and standard deviation of 14.55. This indicates that chemistry teachers in urban schools had higher competence in identification of laboratory of apparatus than others teaching chemistry in rural schools.

Table 5: Two-tailed t-test difference between mean achievement of teachers in rural and urban schools in identification of laboratory apparatus

		Levene's test for Equality of Variance		t-test for Equality of Means		
		F	Sig.	t	df	Sig (2-tailed)
Location	Equal variances assumed	.706	.401	2.884	452	.004
	Equal variances not assumed			2.884	451.917	.004

Table 5 indicates that there is a significant difference at 0.05 between teachers in rural and urban schools' ability to identify laboratory apparatus. This is as a result of the fact that the 2-tailed level of significance of 0.004 is less than 0.05. Therefore, the null hypothesis that location of chemistry teachers has no significant effect on their mean achievement in identification of laboratory apparatus is rejected.

Discussion and Educational Implications of the Findings

The study reveals that only eleven out of the seventy-one commonly used apparatus in chemistry laboratory were effectively identified by the teachers. It is an indication of Chemistry teachers' low competence in laboratory management. It means majority of the pieces of apparatus meant for chemistry practical are not effectively utilized by the teachers. The finding of this study supports the assertion by Njoku (2007) that something seems to be wrong in the way and manner teachers teach practical chemistry. This may be why students are yet to develop competence and confidence when tackling practical examination questions in chemistry. This finding tends to confirm the earlier works of Adeyegbe (1997), Achimugu (1997) and Ikeobi (1999) which traced students poor performance in practical chemistry to teachers inability to take them through practical sessions in the laboratory as they, teachers could not display correct understanding of science processes and unable to organize and conduct practical classes.

The implication is that students may not be having the exposure to practical experiences that should prepare them for the psychomotor and cognitive domains of learning and they may have been deprived of the acquisition of science process skills that prepare them for higher institutions and work of life. It equally implies that the contents in the senior school chemistry curriculum which expect the teachers to demonstrate the preparation of gases and their tests for identification may not have been taught or at best theoretically presented to the learners. This may lay credence to WAEC chief examiner's reports (2008, 2009, and 2010) that candidates performed poorly in practical chemistry and areas that require demonstration of competency in preparation of gases.

The findings of this study indicates that the mean achievement of male chemistry teachers in the identification of laboratory apparatus is higher than the female teachers. It mean gender influences teachers' level of competency in the usage and management of laboratory apparatus. This finding finds support in the work of Udoh (2008) which recorded that male and female chemistry teachers differ significantly in their classroom interaction. It agrees with Ekene, Egolum and Nnoli (2011) who reported that male teachers have

higher knowledge of the use of ICT in education than the female teachers. This suggests that the bias earlier reported by Kable and Lakes (1998) and Edu (2006) that males are more likely than females to find science interesting or to dream that they would use mathematics and science abilities, may still be prevailing among the serving teachers. This should not be so especially when both teachers have passed through the same institutions during pre-service training and are exposed to similar environmental teaching experiences in the schools. It however, suggests that the female teachers still need extra motivation to accept chemistry practical exercises as part and parcel of the school activities that would bring about the desired behavioural changes in the learners.

The results in Table 4 and 5 show that there is significant difference in the ability of urban and rural senior schools Chemistry teachers in identification of the commonly used pieces of laboratory apparatus. Teachers in urban schools recorded higher mean achievement in identification of pieces of apparatus than others in rural schools. It indicates that location of chemistry teachers may have influenced their competency in the management of laboratory activities. This may be obvious as rural schools tend to lack basic science equipment. Okebukola (2002) noted that good learning environment stimulates positive response in teaching and learning situation, but the reverse is the case where such is lacking. Nbina (2010) pointed out that even though provision is made for integration of both theory and practicals in science teaching, but, because of the lack of good laboratories and science equipment mostly in the rural schools, studies revealed that teachers do not completely comply with the provision and many teachers cannot detect and repair simple faults in their science equipment. This pre-supposes that teachers in the rural schools are still lagging behind in terms of actual conceptualization of the theoretical and practical learning of chemistry contents as specified in senior school chemistry curriculum.

Educational Implications of Findings

The limited knowledge of chemistry teachers in identification of commonly used laboratory apparatus implies that most of the chemistry practical activities expected of learners have not been attended to as the main facilitators lack the cognitive capability. Science learning at the secondary school level may likely continue to be in jeopardy. The teachers may not have been preparing and testing the gases specified in the senior school chemistry curriculum. It implies some of the topics are inadequately treated or even skipped and hence students are ill-prepared for the external examinations. It means the aims of teaching chemistry at the secondary schools are not effectively achieved. It becomes very obvious why there tend to be the observed failure of learners in meeting the societal aspiration as there are inherently very weak and faulty foundations in science teaching at the senior school level of education.

Conclusion

It can be concluded that chemistry teachers are yet to be at ease when conducting chemistry practicals as the needed knowledge is seemingly inadequate. This seems to be part of the yawning gaps in classroom implementation of the senior school chemistry curriculum which needs urgent remediation.

Recommendations

The researchers make the following recommendations. Teachers training institutions should intensify efforts in exposing pre-service chemistry teachers to all the needed rudiments of laboratory management. Conscious efforts should be made by such institutions to allow the trainee chemistry teachers effective access to the pieces of apparatus required for senior school chemistry curriculum.

State ministries of education and local government education authorities should organize long vacation workshops specifically on laboratory management for science teachers. Science laboratories should be adequately built and equipped by state governments, communities and non-government organizational interested in science education.

Chemistry teachers should endeavour to improve on their level of competence by attending seminars, subject panel workshops and conferences organized by Science Teachers Association of Nigeria and Chemical Society of Nigeria.

Education Trust Fund should device means of assisting science education at secondary level by allotting a percentage of its fund to building and equipping science laboratories.

The federal government in conjunction with state governments should as a matter of deliberate science education policy ensure that each ward has a model science laboratory as a reference point for other schools within the area.

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