DIAGNOSIS OF BASIC ELECTRICITY TEACHERS' REPAIR KNOWLEDGE OF SIMPLE FAULTS IN COMMON BASIC ELECTRICITY LABORATORY APPARATUS IN ENUGU STATE

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Abstract

This study sought to determine Basic Electricity teachers' knowledge of the possible causes of simple faults, nature of faults and repair procedures for faults in common Basic Electricity laboratory apparatus in Enugu State. These faulty apparatus, the teachers ought to fix in order to sustain continuous services in their schools' workshops. The study also queried whether teachers' qualifications; gender and work experience had effects on their knowledge of repair procedures of Basic Electricity equipment. Eighty six Basic Electricity teachers and seven technocrats were involved in the study. Five research questions and one hypothesis guided the study. Percentage and chi-square (X2) statistics were used to analyze the data. The results showed that (1) Teachers generally, lack the basic knowledge of repair procedures for minor faults in Basic Electricity apparatus and (2) Qualification, gender and experience have no significant effect on the Basic Electricity teachers' knowledge of faulty equipment repair procedure. Because of the existence of large number of faulty Basic electricity apparatus, (some of which are minor faults) lying waste in the Basic Electricity laboratories, the study highlighted some of its implications in curriculum innovation and in meeting up with the much needed science instructional materials production, procurement and utilization in the schools. Based on the findings, recommendations were made.

The Nigerian Secondary Schools Science curriculum recommended the use of guided discovery in science teaching and learning. Guided discovery is the learning approach in which the learner's mind is actively engaged through a series of well-structured experiences (Ivowi, 1993). In fact, guided discovery is activity oriented and goes beyond "minds-on" to also "hands-on" learning. In 'minds on—hands on' learning activities, students are to a large extent given learning autonomy to plan, conduct and record their experiments and results. The benefits accruing from hands on practical activities have been well documented in literature. Some of them include: concept development and facilitating learning (Nebo, 2012); improving communicative skills, psychomotor skills, computational skills, problem-solving and co-operative learning skills plus other requisite skills (Toba, 2010), in addition to increase in students' cognitive and affective outcomes (Mubob and Kanu, 2003). Practical activities involve students in the acquisition of series of process skills such as observing, classifying, interpretation, predicting events, designing experiments, organizing information, reporting completely and accurately, generalizing etc. (Aka and Usman, 2003). These are keys to the acquisition of scientific literacy. Without practical activities, students are denied access to the acquisition of process skills and science learning.

Practical activities in science require the use of relevant science equipment that will aid the investigation, verification or demonstration of the concept under study. Laboratories should be well equipped with learning materials/equipment necessary to always engage students in practical activities. However, inadequacy of science instructional materials/equipment in the schools has been well reported. This might be due to a number of factors including inadequate stocking of laboratories, large number of faulty equipment, inadequate fund to replace faulty ones and or increase stock, lack of repair/maintenance culture on faulty equipment, population explosion in the schools resulting in increased number of students who enroll in Basic Electricity laboratory has been well observed and noted. Neboh (2012), noted that most of the apparatus in our Basic Electricity workshops in the state are in dysfunctional states due to minor faults which the Basic Electricity teachers should tackle. In many cases, the faults in the equipment are minor and ought to have been repaired by the Basic Electricity teachers themselves. This situation should not be allowed to continue especially at this time when science and technology education is poorly funded.

What are the nature and causes of these faults? Are there precautionary measures that could have been in place to avoid these equipment failures? The system is expected to consider measures to ensure the continued performance of the available apparatus in schools. It is also important to consider teachers' gender and the level of their qualifications and experiences that should be expected to contain fully the repair and maintenance of these apparatus. One necessary question therefore should be, is there no way of sustaining the workability of the available Basic Electricity apparatus through the repair of faulty ones by the Basic Electricity teachers? It was in the light of this that this study was conceived.

The Purpose of this Study therefore was to find out the:-

Possible causes of simple faults in common Basic Electricity apparatus

a. What the faults are and their causes.
b. Repair procedures by the Basic Electricity teachers.
c. Precautionary measures adopted to minimize damage by teachers.

Research Questions

The following research questions guided the study:

1. What are the possible causes of simple faults in common apparatus?
2. What is the nature of such faults?
3. What are the repair procedures for such faults?
4. Do the Basic Electricity teachers have the basic knowledge/skills for repairing such faults?
5. What is the effect of teacher qualification, gender and work experience on knowledge of repair procedures for such simple faults?

Hypothesis

The following hypothesis was raised to further help answer the research questions.

H_O: Teacher qualification, gender and experience do not have significant effect (P=0.05) on the Basic Electricity teacher's knowledge of the repair procedures of simple faults in equipment.

Method

Design

This was a survey study designed to find out causes of simple faults and their repair procedures in common Basic Electricity equipment.

Area of Study

The study was carried out in secondary schools in Udi and Ezeagu L.G.A of Enugu State.

Population

The study involved Basic Electricity teachers in the secondary schools studied and technocrats who are staff of institutions of higher learning and are certified electricity education lecturers. In all, 86 teachers drawn from 43 secondary schools in the two Local Government Areas constituted the population and 7 technocrats from 2 tertiary institutions in Enugu State were involved.

Sample and Sampling Techniques

No sampling was done, the entire population was studied

Instrumentation

A survey of faulty equipment was carried out in the workshops of the schools studied. An inventory on Basic Electricity faulty Apparatus instrument (BEFAI) was then developed by the researcher. The instrument had three parts, A, B and C. Part A sought the background information of the teachers in relation to their qualifications, gender and work experience. Part B consisted of a list of 12 Basic Electricity apparatus commonly used in Basic Electricity experiments and part C sought information on the respondents' (teachers and technocrats) knowledge of possible causes of faults, repair procedures for faults and necessary precautions against such faults. The instrument was administered on the respondents by the researcher.

Validation of Instrument

The instrument was face validated by two technocrats who are university lecturers who majored in electricity education of the Department of Technology and Vocational Education of Enugu State University of Science and Technology Enugu. It was made up of a list of twelve commonly used Basic Electricity apparatus and also identified in the survey carried out in the schools studied. Their corrections and comments were used to modify the instrument to have the final draft.

Reliability of the Instrument

In order to ensure the reliability of the instrument, a trial-test was carried out on two secondary schools offering Basic Electricity in Enugu North and Enugu South Local Government Areas in Enugu State that are outside the areas of the study. Data collected was subjected to Cronbach Alpha Statistics in order to determine the internal consistencies of the items in the instrument. Overall reliability estimate of 0.72 was obtained. This indicated that the instrument was reliable.

Results:

The results of the study are as shown in the tables 1, 2 and 3 below.

Table I: List of Common Apparatus, their Possible Causes of Fault, Nature of Faults, Effects, Repair Procedures and Precaution.

S/N	Apparatus	Possible cause of fault	Nature of fault	Effect of fault	Repair procedure	Precaution against damage
1	Ohm meter	Corrosion of Battery terminals	Battery does not power unit	No deflection of spindle	Clean battery terminals	Always clean battery terminals
2	Energy meter	Charred meter terminals	Stoppage of current flow	Load cannot be powered	Disconnect and perform fresh connection	Always tighten terminal bolts properly
3	Watt meter	Protective Fuse Failure	Battery does not receive power to measure	No spindle deflection	Replace fuse	Use correct fuse
4	Ammeters	• Excessive current	• Burning of coil burning of resistor	• No deflection of pointer	• Replace the coil with correct SWG value. Replace	• Avoid excessive current

				with correct resistor value and wattage.		
5	Voltmeter	• Excessive current	• Burning of coil Burning of resistor	• No deflection of pointer	• Replace coil with correct SWG value. Replace with correct resistor value and wattage	• Avoid excessive current
6	Potentiometer	• Excessive current Dragging of Jockey along wire	• Sagging of wire Wearing of wire	• Inaccurate measurement	• Replace of retie wire	• Avoid excessive current. Do not drag wire. Tie connection of terminals
7	Standard resistor	• Excessive current	• Burning or breaking of wire	• Total experimental error or open circuit	• Replace wire with correct length, SWG value and cross sectional area	• Avoid excessive currents.
8	Variable resistor (rheostat)	• Excessive current Rusting, strong dragging of slider	• Breakage of wire, stiffening of slider wearing of wire	• No variation of resistance in the circuits	• Replace wire with one of same SWDG value length and cross-sectional area. Scrapping of rust and coiling	• Avoid excessive current sligh dragging slider proper storage oiling sometimes
9	Resistance box	• Excessive current	• Breakage of wire	• Total experimental error	• Replace wire	• Avoid excessive current
10	Accumulator	• Leaving the electrolyte in the battery after use	• Death of cells run down electrolyte	• No (sufficient) voltage supply	• Replace cells Replace electrolyte	• Pour away the electrolyte and dry cells, after drying the cells, after use.
11	Battery charger	Control knob failure, sends higher voltage value to power unit	Unrectified current flows to the battery, due to the diode(s) failure	Battery does not charge	Detect the damage diodes and replace	Ensure that the input meter reads the selected voltage at the control knob

12	Soldering Iron	Long duration of powering unit without usage	Heating element open circuited	No heating of elements	Replace heating element	Unplug apparatus if not in use for a long time

The above table (1) gives a fascinating insight into the possible causes of damage, nature of faults, simple repair procedures and precautionary measures needed for the apparatus. If these precautionary measures are sustained, minimal faults will be experienced in these instruments. These inputs were as perceived by the technocrats on the twelve common Basic Electricity apparatus identified in the survey conducted by the researcher.

Table 2: Frequencies and Percentages of Teacher in Terms of their Knowledge of Causes of Faults and of Repair Procedures (Percentages in parenthesis)

S/N	APPARATUS 1	Knowledge of cause of fault		Knowledge of repair procedure	
		YES	NO	YES	NO
1	Ohmmeter	58 (67.4)	28 (32.6)	4 (4.7)	82 (92.3)
2	Energy Meter	29 (33.7)	57 (66.3)	0 (0.0)	86 (100.0)
3	Wattmeter	8 (9.3)	78 (90.7)	0 (0.0)	86 (100.0)
4	Ammeters	64 (74.4)	22 (25.6)	7 (8.1)	79 (91.9)
5	Voltmeters	61 (70.9)	5 (29.1)	6 (9.0)	80 (7.0)
6	Potentiometer/meter bridge	17 (19.8)	69 (80.2)	11 (12.8)	75 (87.2)
7	Standard resistor	0 (0.0)	86 (100.0)	0 (0.0)	86 (100.0)
8	Variable resistor	0 (0.0)	86 (100.0)	0 (0.0)	86 (100.0)
9	Resistor box	0 (0.0)	86 (100.0)	0 (0.0)	86 (100.0)
10	Accumulator	48 (55.8)	38 (44.2)	0 (0.0)	86 (100.0)
11	Battery charger	0 (0.0)	86 (100.0)	0 (0.0)	86 (100.0)
12	Soldering Iron	0 (0.0)	86 (100.0)	0 (0.0)	86 (100.0)

A cursory look at the table, (2), above shows that majority of the teachers do not know the causes of faults and repair procedures in most of the apparatus. They only know how to manipulate them. These facts can be seen in items 7, 8, 9, 11 and 12 where 100% of the teachers do not know either the causes of the problems or their repair procedures.

Table 3: Frequencies and Chi-square (X^2) Values of Teachers' Knowledge of Repair Procedures with Respect to Qualification, Gender and Experience

S/N		knowledge of repair Procedure				
	Qualification	Adequate	Inadequate	Total	df	X^2
A	B.Sc/B.ed & above in Industrial	13	36	49		
	Technical	8	29	37	1	0.2753

	education	21	65	86		
	HND, NCE & others					
	Total					
B	Gender					
	Male	18	54	72		
	Female	3	11	14	1	0.3423
	Total	21	65	86		
C	Experience					
	Below five	5	24	29		
	years	16	44	57	1	1.2212
	Five years &	21	65	86		
	above					
	Total					

X^2 (1 df, 0.05) = 3.841

Table 3 shows that the null hypothesis was not rejected. Hence, teachers' knowledge on repair procedure of apparatus do not depend on qualification, gender and experience.

Discussion

Table I provides the general basic information on what possible causes of damage or fault, the nature of faults, simple repair cum maintenance procedures and the precautionary measures necessary to sustain the workability of the instruments. This information was as perceived by the technocrats.

This table actually reveals that the abilities to repair some simple faults are not too far fetched and are within the capabilities of the Basic Electricity teachers. Again, necessary precautionary procedures that will preserve the life or workability of the apparatus are well identified. Basic Electricity teachers can very well maximize this part of this study to increase the instructional materials available in the Basic Electricity laboratories and with this, increased practical activities will be ensured in the schools, and the significant effort of highly incorporating practical activities into Basic Electricity lessons to improve students understanding of science concepts and achievement in science will be maximized (Aka and Usman, 2003).

Table II shows that while some teachers know, majority of them do not know the possible causes of simple faults in the apparatus they use to carry out the work. This is another very appalling situation and might be responsible for very large number of faulty Basic Electricity apparatus wasting in the schools. The table also reveals that Basic Electricity teachers lack the basic knowledge to repair simple faults in apparatus. This might be the reason for common practice of teachers delaying practical classes till the examination period on the ground of preserving apparatus against damage for use for examination purposes. This practice is improper and kills the spirit of science and technology teaching and learning. Students are by nature curious. They are also active in learning situations with opportunities for them to enquire, test, speculate and build their own constructs of knowledge and hence achieve meaningful learning. Concrete construction of meaning could be achieved if practical activities are effectively constructed in schools (Aka and Usman, 2003).

The results of the chi-square (X^2) test (Table III) show that the null hypothesis is not rejected. Hence the Basic Electricity teachers' knowledge of repair procedures on apparatus does not depend on qualification, Basic Electricity teachers, irrespective of academic qualification, gender and experience generally lack the knowledge of repair procedures for minor faults in Basic Electricity apparatus. This has a serious curriculum implication in teacher training institutions.

Implications

The findings of this study have some curriculum implications. The Basic Electricity teachers during training might not have acquired sufficient knowledge/skills on repair of simple equipment faults in their workshop courses. Perhaps the workshop courses did not expose them to enough repair experiences on minor faults in science equipment. This therefore might require curriculum review on workshop programmes. If teachers are capable of repairing simple faults in science equipment, the skills/knowledge should aid them in improvisation of science materials that are highly needed in science practical activities.

Conclusion

To promote inquiry and discovery learning in science and technology, practical activities are foremost. There are, however, insufficient Basic Electricity/science instructional materials/equipment in the schools (Nda, 2001). Worst of it all is the existence of a large number of faulty equipment in the science/ technology laboratories. Some of the faults are minor and can be repaired by the Basic Electricity/science teachers. Unfortunately, the teachers lack the basic knowledge of repair procedures for such faults. This study has however provided some answers to some of the repair procedures and necessary precautionary measures to minimize damage (table I). The need for curriculum review to include more workshop courses in the academic programmes of universities and colleges of education is highly recommended. The need also to send regular teachers on workshops on repair of simple faults and maintenance procedures on Basic Electricity equipment on regular bases is highly needed. This will help in meeting up with the challenges of curriculum innovations for science material production and utilization.

Recommendations

In view of the findings of this study, the researcher makes the following recommendations;

1. There should be curriculum review in Basic Electricity teachers training programmes to include maintenance and repair of most Basic Electricity apparatus and science equipment.
2. Workshop on repair and maintenance procedures on Basic Electricity apparatus/science equipment should regularly be organized for serving Basic Electricity teachers.
3. Industrial visits should be encouraged for serving Basic Electricity teachers to industries to see how various apparatus are used and maintained in factories.

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