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AN INVESTIGATION INTO THE LEVEL OF ADEQUACY OF RESOURCES FOR TEACHING SECONDARY SCHOOL PHYSICS IN ENUGU STATE, NIGERIA

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Keywords*: Level of adequacy; Physics teaching resources.*

Abstract : *The aim of this study was to investigate the level of adequacy of resources for teaching physics at the secondary schools in Enugu State, Nigeria. Such resources included physics teachers and equipment. Eighty eight physics teachers and eight hundred and eighty students drawn from state public secondary schools in Enugu State constituted the sample for the study. Relevant data for the study were collected using researchers' made structured questionnaires, one for the availability of laboratory equipment and the second for the level of utilization of such equipment. The reliabilities of the instruments were computed using Kuder-Richardson (KR-21) and Cronbach (α) formular, showing coefficients of 0.81 and 0.85 for the availability and utilization of the equipment instruments respectively. Four research questions and three null hypotheses were formulated to guide the study. The research questions were answered using means and standard deviations, while the hypotheses were tested at 0.05 level of significance, using one way Analysis of Variance (ANOVA) respectively. The result of the study indicated that resources for teaching physics, that is, personnel and laboratory apparatus/equipment are inadequate in terms of availability. The result also indicated that even the available laboratory apparatus were grossly underutilized, irrespective of the teachers' qualifications and experience. Some recommendations were made to mitigate these shortfalls.*

Introduction

Physics is a branch of science which in itself according to Akpan, Edem and Anefick (2019) is a systematic study of natural phenomenon. Such study allows students to experience the richness and excitement of natural world as they engage in critical thinking, inquiry and demonstration of skills.

Physics is concerned with the study of matter, motion, waves and energy. Physics is the bedrock of every technological development of any country. The technological development of a nation can rightly be said to be based on

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the quality of her physics education. Any developing country like Nigeria, who does not recognize physics and technology as dominant indices of develop mind may not be thinking right.

The practical application of discoveries in several areas of physics such as mechanics, electricity, optics, thermodynamics, vibration, atomic and nuclear physics, molecular physics, solid state physics etc has made transportation easier, safer, faster and more efficient; improved the health of people through improved diagnostic processes in medicine and enhanced the production of different drugs. Acknowledging the importance of physics, the federal Republic of Nigeria (FGN, 1985) felt that there was need for physics to be one of the core subjects in the secondary school curriculum.

However for decades, there has been outcry and criticism about the science (physics inclusive) taught to and learned by students in Nigeria, both at the secondary schools and other higher institutions. The concern is whether the science taught was appropriate and relevant to the scientific needs of the nation. The same situation existed in other climes in early 20th century resulting in a shift of emphasis from explanatory and computational mode of teaching science to inquiry and investigative problem-solving mode. The latter mode emphasized laboratory activities in all science teaching where laboratory work was advocated to lead rather than lag the classroom phase of science teaching. In this advocacy also, laboratory work should no longer be just verifications of theories, but illustrations of problems and conclusions of how such works should lead to solutions of such problems.

The most crucial resources for successful teaching of physics at any level are the teachers (and technologists at Post-secondary levels) and well equipped laboratories. For the success of the advocacy mentioned above, qualified, competent motivated and dedicated physics teachers should be available in at least majority of the schools in Enugu State. One of the greatest challenges to school administrators particularly in rural areas, is that of attracting and keeping teachers. According to Eze (2000), the main causes of acute shortage of well qualified teachers in rural areas, is the practice of centralized recruitment, posting and transfer of teachers, which often ignore areas of dire need, thereby affecting rural areas seriously.

The issue of having the major science laboratories is easier because the state Ministries of Education and different public examination bodies go and inspect the laboratories before any school is approved for their students to participate in such public examinations. However, the acquisition of laboratory equipment/ apparatus occur in three modes in most secondary schools. One is the occasional bulk purchase of science equipment by state government and distribution to schools. The disadvantages of this mode is that it is not regular, and while making such bulk purchases, vital considerations are not made in terms of model, design, currency, quality, durability and performance of the apparatus. The second mode is the direct purchase of laboratory apparatus a few weeks before the annual public examinations for secondary schools in the country by the recognized (authorized) examination bodies such as West African Examination Council (WAEC) and the National Examination Commission (NECO). The third mode is where some schools who do not have money to do purchases go round the older schools whose laboratories are richer in laboratories apparatus to borrow the items of apparatus which the examination bodies

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advise physics teachers in all schools to get ready for practical examinations. Such borrowed apparatus are returned to the owner schools immediately after the examinations.

These two last modes should not be encouraged for two reasons: one, experienced teachers rightly guess what experiments are likely to be expected in practical examinations and coach their students the types of experiments that are usually carried out with such apparatus. Two, the laboratories in many schools would never be properly equipped as they continue to borrow and return apparatus to their owners. More seriously is that these modes of acquisition of laboratory resources might have been the source of examination leakages frequently reported in many schools in the country.

Purpose of the Study

There has been a great deal of research on secondary school physics laboratory resources, their availability and utilization, Mogboh (1993), Eze and Ugwu (1997), Mamman (1985), and Cookey (1992). The results of these researches indicated very inadequate availability and utilization of these resources. As can be seen, those researches cited above, were carried out three or two decades ago.

This present study was designed to investigate the status of physics resources in terms of availability of physics teachers and laboratory equipment and how adequate or otherwise these resources are. Specifically the study was aimed at finding out:

(i) The extent of availability of qualified physics teachers with respect to location of the schools.
(ii) The extent of availability of laboratory equipment with respect to the location of schools
(iii) The extent of utilization of basic physics laboratory equipment by the students with respect to the location of the schools.
(iv) The influence of qualification and experience of teachers on the utilization of physics laboratory equipment.

Research Questions and Hypotheses

The following research questions guided the study and hypotheses were tested at 0.05 level of significance.

Research Questions

(i) To what extent are qualified physics teachers available in secondary schools in Enugu State?
(ii) To what extent are recommended basic physics laboratory equipment available in secondary schools in Enugu State with regard to location?
(iii) What is the extent of utilization of basic physics laboratory equipment by students in secondary schools in Enugu State with regard to the location of the schools?
(iv) How do the qualification and experience of physics teachers in secondary schools in Enugu State influence the extent of utilization of available basic laboratory equipment?

Hypotheses

Ho_1: There is no significant difference between the mean ratings of the responses of urban and rural physics teachers on the extent of availability of basic physics laboratory equipment in secondary schools in Enugu State.

Ho_2: There is no significant difference between the mean responses of the urban and rural students on the extent of utilization of basic physics laboratory equipment in secondary schools in Enugu State.

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Ho_3: There is no significant difference between the mean responses of qualified and unqualified teachers on the extent of utilization of basic physics laboratory equipment in secondary schools in Enugu State.

Ho_4: There is no significant difference between the mean ratings of responses of the experienced and inexperienced physics teachers on the extent of utilization of basic physics laboratory equipment in secondary schools in Enugu State.

Research Method

This is a descriptive survey research design study, which was carried out among 88 secondary schools in Enugu State. The sample for the study was 88 physics teachers and 880 physics students in those schools, making a total of 968 respondents (**Source**: Planning and Statistics Department Post Primary Schools Management Board, Enugu, 2021).

Simple random sampling technique was used to select 10 students and one teacher (the most senior) from each of the schools. Two types of questionnaire (one for teachers and another for students) were used to collect data for the study. The responses to the items of the instruments were rated using four point scales as follows: Always utilized (4); Frequently utilized (3), Occasionally utilized (2), Rarely utilized (1). As regards availability of laboratory equipment, a minimum number of each item of equipment expected to be in the laboratory had been worked out by the Science Teachers Association of Nigeria (STAN) (1988) and adopted by the Federal Ministry of Education. So the proportion (ratio) of each item of equipment available in a school to the benchmark above is computed. The mean of these proportions $(\bar{x}_p)$ for each item in all the schools and their corresponding standard deviations were also computed. The mean proportions were categorized into indices of availability as follows:

0.00 - 0.25 - Very inadequately available (VI)
0.26 - 0.50 - Inadequately available (ID)
0.51 - 0.75 - Adequately available (AD)
0.76 - 1.00 - Very adequately available (VA)

In respect of utilization of laboratory equipment, the weighted means $(\bar{x}_w)$ of the responses were categorized as indices of extent of utilization as follows:

Less than 1.49 - Rarely utilized (RU)
1.50 - 2.49 - Occasionally utilized (OU)
2.50 - 3.49 - Frequently utilized (FU)
3.50 - 4.00 - Always utilized (AU)

The instruments were peer validated and trial tested. Kuder-Richardson formular 21(K-R.21) was used to compute the coefficient of reliability for the availability of laboratory equipment, while Cronbach (α) formular was used to compute the coefficient of reliability for the utilization of laboratory equipment. Weighted means and standard deviations were used to answer the research questions. While a one-way analysis of variance (ANOVA) was used to test the hypotheses.

Results

The results of the study are presented according to the research questions and hypotheses.

Research Question 1: To what extent are qualified physics teachers available in secondary schools in Enugu State?

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From section A of the teachers' instrument which sought from them their individual bio-data, it was found that sixty four (64) of them have B.Sc. honours in either physics or engineering, and Education qualifications. The twenty four (24) others have only B.Sc. honours in Physics or Mathematics only. Out of eighty-eight teachers who took part in this study were qualified while twenty four of them were technically not qualified.

Research Question 2: To what extent are recommended basic physics laboratory equipment in secondary schools in Enugu State with regard to location?

Table 1 below presents the result for answering research question 2.

Table 1: Number of items of Basic Physics Laboratory Equipment in Ranges of mean proportion $(\bar{x}_p)$of availability with regards to location of schools.

Range of mean proportion $(\bar{x}_p)$	**Remarks**	**Number of Items of Equipment in each Range**	
		Urban	**Rural**
0.00 – 0.25	VI	5	19
0.26 – 0.50	ID	50	43
0.51 – 0.75	AD	38	34
0.76 – 1.00	VA	7	4
		100	**100**

Note: VI = Very inadequate available; ID = Inadequate available;
AD = Adequately available; VA = Very adequately available

Table 1 shows that out of 100 items of the basic physics laboratory equipment recommended by the Federal Ministry of Education, urban schools have 5 items with the mean proportion $(\bar{x}_p)$ indicating very inadequate available (VI) while rural schools have 19 in that category. The numbers of equipment having mean proportion $(\bar{x}_p)$ indicating inadequate available (ID) are 50 and 43 respectively. For the mean proportions $(\bar{x}_p)$ indicating adequately available, urban and rural school have 38 and 34 items respectively. Finally for the mean proportion $(\bar{x}_p)$ indicating very adequately availability of equipment, urban and rural schools have 7 and 4 respectively.

Research Question 3: How do the qualification and experience of physics teachers in secondary schools in Enugu State influence the extent of utilization of available basic laboratory equipment?

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Table 2: Number of items of Basic Physics Equipment in Ranges of weighted means proportion ($\bar{x}_w$) indicating the Extent of utilization by teachers with regards to their qualification and experience.

Range of weighted means ($\bar{x}_w$)	Remarks	Number of Items of Equipment utilized by Teachers				
		Qualified	Unqualified		Experienced	Inexperienced
0.00 – 0.25	RU	52	89		54	91
0.26 – 0.50	QU	44	11		39	09
0.51 – 0.75	FU	04	00		07	00
0.76 – 1.00	AU	00	00		00	00
		100	**100**		**100**	**100**

Note: RU = Rarely utilized; OU = Occasionally utilized;
FU = Frequently utilized; AU = Always utilized

Table 2 shows that of the 100 items of the recommended basic physics laboratory equipment used in this study, qualified and experienced teachers used 52 and 54 items rarely respectively, while unqualified and inexperienced teachers used 89 and 91 items rarely respectively. The above categories of teachers respectively used 44, 39, 11 and 09 items of equipment occasionally, while 04 and 07 of the items were used by the qualified and experienced teachers frequently. None of those teachers used none of the items always.

Research Question 4: What is the extent of utilization of basic physics laboratory equipment by students in secondary schools in Enugu State with regard to the location of the schools?

Table 3: Number of items of Basic Physics laboratory equipment in the ranges of weighted means proportion ($\bar{x}_w$) indicating the Extent of utilization by students with regards to the location of the schools.

Range of weighted means proportion ($\bar{x}_w$)	Remarks	Number of Items of Lab. Equipment in Ranges of weighted means ($\bar{x}_w$)	
		Urban	Rural
0.00 – 0.25	RU	0.00	0.03
0.26 – 0.50	QU	100	0.97
0.51 – 0.75	FU	000	000
0.76 – 1.00	AU	000	000
		100	**100**

Note: RU = Rarely utilized; OU = Occasionally utilized;
FU = Frequently utilized; AU = Always utilized

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Table 3 shows that out of 100 items of the recommended basic physics laboratory equipment used in this study, urban schools used all of them occasionally. Rural schools used 3 of the 100 items rarely and 97 items occasionally. None of the urban and rural schools used all the items either frequently or always.

Ho_1: There is no significant difference between the mean ratings of the responses of urban and rural physics teachers on the extent of availability of basic physics laboratory equipment in secondary schools in Enugu State.

Table 4: One-way ANOVA classification for the extent of availability of basic physics laboratory equipment with regards to location of the schools.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Ratio	F-Probability	Decision
Between Groups	1	0.2628	0.2628	4.9495	0.0272	S
Within Groups	198	10.5139	0.0531			
Totals	**199**	**10.7767**				

Table 4 shows that F-ratio (4.9495) is greater than F-probability (0.0272), hence Ho_1 is rejected. In other words there is significant difference between urban and rural schools on the extent of availability of basic physics laboratory equipment in Enugu State.

Table 5: Scheffe Post-Hoc of pairs of means for the availability of basic physics laboratory equipment with regards to location of schools.

Group	Count	Mean	S.D	S.E	95% Cont. Interval for Mean
Urban schools	100	0.5549	0.2500	0.2250	0.5052 to 0.6015
Rural schools	100	0.4823	0.2086	0.0209	0.4410 to 0.5237
Totals	**200**	**0.5186**	**0.2327**	**0.0165**	**0.4862 to 0.5310**

Table 5 shows that he mean and the confidence interval for urban schools are higher than similar values for the rural schools. Hence urban schools tend to have more basic physics laboratory equipment than the rural school counterparts.

Ho_2: There is no significant difference between the mean responses of the urban and rural students on the extent of utilization of basic physics laboratory equipment in secondary schools in Enugu State.

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Table 6: One-way ANOVA classification for the extent of utilization of basic physics laboratory equipment by students in secondary schools in Enugu State.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Ratio	F-Probability	Decision
Between Groups	1	0.256	0.256	1.2808	0.2591	S
Within Groups	198	3.9511	0.0200			
Totals	**199**	**3.9767**				

Table 6 shows that F calculated (1.2808) is greater than F-probability (0.02591), hence $H0_2$ is rejected. Therefore there is significant difference between the mean rating of the responses of urban and rural students on the extent of utilization of basic physics laboratory equipment in secondary schools in Enugu State.

Table 7 below shows the Scheffe Post-Hoc Test of pairs of means for utilization of basic physics laboratory equipment by students.

Group	Count	Mean	S.D	S.E	95% Cont. Interval for Mean
Urban schools	100	1.8159	0.1515	0.0152	1.7850 to 1.8459
Rural schools	100	1.7933	0.1302	0.0130	1.7674 to 1.8191
Totals	**200**	**1.8066**	**0.1414**	**0.0100**	**1.7849 to 1.8243**

Table 6 shows that the mean and the confidence interval for mean for urban schools are higher than similar values for the rural schools respectively. Therefore urban school students tend to utilize basic physics laboratory equipment more than rural school students.

$H0_3$: There is no significant difference between the mean ratings of qualified and unqualified physics teachers on the extent of utilization of basic physics laboratory equipment in secondary schools in Enugu State.

Table 8: One-way ANOVA classification for the extent of utilization of basic physics laboratory equipment by teachers with respect to their qualification.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Ratio	F-Probability	Decision
Between Groups	1	8.0757	8.0757	74.8000	0.0000	S
Within Groups	198	21.3770	0.1080			
Totals	**199**	**29.4527**				

Table 8 shows that F-calculated (74.8000) is greater than F-probability (0.0000), hence $H0_3$ is rejected. Therefore there is significant difference between the mean ratings of qualified and unqualified teachers on the extent of utilization of basic physics laboratory equipment.

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Table 9 below shows the Scheffe Post-Hoc Test of significant mean for utilization of basic physics laboratory equipment by teachers with regard to their qualification.

Group	Count	Mean	S.D	S.E	95% Cont. Interval for Mean
Urban schools	100	1.5902	0.4253	0.0425	1.5058 to 1.6746
Rural schools	100	1.1888	0.1872	0.0187	1.1512 to 1.2255
Totals	**200**	**1.3893**	**0.3847**	**0.0272**	**1.3356 to 1.4429**

Table 9 shows that the mean and the confidence interval for mean of qualified teachers are higher than similar values for unqualified teacher respectively. Hence the qualified physics tend to utilize basic physics laboratory equipment more than their unqualified counterparts.

Ho_4: There is no significant difference between the mean ratings of responses of experienced and inexperienced teachers on the extent of utilization of basic physics laboratory equipment in secondary schools in Enugu State with regards to their experience.

Table 10 below shows the results used in testing Ho_4.

Table 10: One-way ANOVA classification for the extent of utilization of basic physics laboratory equipment by teachers with regards to their experience.

Source of Variation	Degree of Freedom	Sum of Squares	Mean Squares	F-Ratio	F-Probability	Decision
Between Groups	1	3.1262	3.1262	27.662	0.0000	S
Within Groups	198	22.377	0.1130			
Totals	**199**	**25.503**				

Table 10 shows that F-calculated (27.662) is greater than F-probability (0.0000), hence Ho_4 is rejected. Therefore there is significant difference between the mean ratings of the response of experienced and inexperienced teachers on the extent of utilization of basic physics laboratory equipment.

Table 11 below presents the Scheffe Post-Hoc Test of pairs of significant mean of the responses of experienced and inexperienced physics teachers on the extent of utilization of basic physics laboratory equipment.

Group	Count	Mean	S.D	S.E	95% Cont. Interval for Mean
Urban schools	100	0.4517	0.04552	0.0425	1.4757 to 1.6549
Rural schools	100	0.1482	0.0148	0.0187	1.2859 to 1.3447
Totals	**200**	**0.3580**	**0.0253**	**0.0272**	**1.3904 to 1.4902**

Table 11 above shows that the mean and the confidence interval for mean values for the experienced teachers are higher than similar values for inexperienced

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teacher. This indicates that experienced teachers tend to utilize basic physics laboratory equipment more than their inexperienced counterparts.

Findings

The major findings of this study are summarized as follows:

(i) The level of available qualified physics teachers in secondary schools in Enugu State is inadequate.

(ii) The level of recommended basic physics laboratory equipment available in secondary schools in Enugu State is equally inadequate. This low level of availability of basic laboratory equipment, is worse in rural schools than their urban counterparts.

(iii) The few qualified and experienced teachers tend to utilize the few available equipment more occasionally than their unqualified and inexperienced counterparts.

(iv) Urban schools students tend to utilize the basic physics laboratory equipment more occasionally than their rural schools counterparts.

Discussion

The role of physics in the technological development of any nation was well discussed in the introduction to the report of this study. It was also emphasized that the proper teaching and learning physics is only possible if the resources for implementing these are adequate. For the availability of the resources, in terms of physics teachers and recommended basic laboratory equipment, the results of this study show that generally the physics teachers and basic laboratory equipment are inadequate. Furthermore, these resources (teachers and equipment) are more in the urban schools than rural schools. Unfortunately only 19 out of the 88 schools used in this study are urban schools. These results indicate that majority of the schools do not have qualified and experienced teachers and also the basic physics laboratory equipment. This finding agrees with the reports of Mbakwe (1989) and Mogboh (1993) that laboratory equipment in secondary schools are in short supply.

These reports cited were given about two decades ago and it means the problem has persisted and therefore raises questions. However, information available to the researchers was that during the periods of the cited reports above, there were reported cases of breakings into the schools' science laboratories all over the state, and carting away of laboratory equipment by robbers. Rural schools were reported to have suffered more in the laboratory equipment loses than the urban schools.

The preponderance of qualified and experienced teachers being more in urban than rural schools has been mentioned earlier in this study. This was blamed on centralized posting and transfer of staff of PPSMB, which do not seem to take cognizance of the needs of the schools in this regard.

On the utilization of the few available laboratory equipment, the results show that only very few qualified and experienced teachers utilize the laboratory equipment occasionally. Nnabuife (1996) reported that some of our secondary schools have their laboratories permanently locked and the keys held by principals, who in most cases are non-scientists. According to him, the priority for such principals is more on making sure that the equipment are not carted away as earlier mentioned in this report. It is our opinion that under- or non-utilization of any resources, either material or human can be termed wastage.

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One of the findings of this study is that urban students tend to utilize the laboratory equipment more than their rural schools counterparts. We earlier talked on the adhoc purchases or borrowing of equipment, and teachers "coaching" students on the possible uses of such equipment is not the best at all. Practical activities in the laboratories should be familiar with all types laboratory equipment. Regular practices would also enable students to be confident in themselves and answer any practical questions in external examinations.

Conclusion

Based on the findings of this study, the following conclusion can be drawn. The adequacy of resources for teaching physics in the secondary schools in Enugu state has been determined. Qualified and experienced teachers are inadequate in the state and those available are concentrated in urban schools, which incidentally are few (19 out of 88 used in this study).

Laboratory equipment are in general inadequately available. Even the available laboratory equipment are utilized occasionally or rarely, resulting in underutilization. The inadequacy and underutilization of even the available laboratory equipment definitely result in poor performance in physics practicals in public examinations.

Recommendation

Based on the outcome of this study, the researchers make the following recommendations:

1. Enugu State Ministry of Education, in liaison with the State Post Primary Schools Management Board could continue to bulk-purchase all science laboratory equipment for secondary school sciences, physics inclusive. The Ministry should request the advice of experts in this because most equipment are becoming electronic and digital. They should also realize that MATLABs are now in existence for virtual laboratory activities.
2. In view of recommendation 1. above, physics teachers in the state secondary schools should be sponsored to professional or state organized staff capacity building workshops where the teachers could come abreast of global best practices in equipment usages.

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