



Administrators' Awareness, Procurement and Management of Virtual Laboratories for Teaching Science Subjects in Secondary Schools: A Case Study

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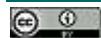
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Abstract

Previous studies have documented numerous benefits of using Virtual Labs (VLs) in promoting effective teaching of science subjects. The low level of teachers' awareness, accessibility, and utilization of VLs in schools is also known. To the researchers' knowledge, what is yet to be known is the extent of administrators' awareness, procurement, and management of VLs in schools which have implications on teachers' accessibility and utilization of VLs. This study adopted a descriptive survey design. A questionnaire (AAPMVLQ), with Cronbach alpha ($\alpha = .83$), was administered to a sample of 662 secondary school principals and vice-principals drawn from 271 public schools in Cross River State Nigeria. Findings revealed that the level of administrators' awareness, procurement, and management of VLs in secondary schools is very low. The low level of awareness was attributed to the poor supply of modern facilities to schools in the area of study. While the low levels of procurement and management were attributed to the low level of awareness of administrators. The conclusion and implications of these findings are that the teaching of science subjects at the secondary school level is witnessing a major setback and will continue if immediate actions are not taken to redress this issue. The poor academic performance of students in science subjects could also be liberated in the future if lessons are made more experiential by providing modern teaching aids such as VLs.

Keywords: Administrators; Awareness; Procurement; Laboratory; Science.



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1. Introduction

In most secondary schools, both science teachers and students complain of difficulties in getting on with science subjects. Mostly, those topics involving practical or hands-on activities. Students claim that science subjects and their topics are very vast and are not often covered by teachers before examinations. Surprisingly, students' academic performance in science subjects is nothing to write home about (Akhiehiero, 2011; Kalu, 2019). Furthermore, Falode and Onasanya (2015) revealed that out of the students that sat for SSCE physics in 2007, 2008, 2009, 2010, and 2011, only 43.19%, 48.26%, 47.83, 51.27% and 63.94% respectively got at least a credit pass in the subject while the rest failed. Kalu extended further revealed that only 27.95%, 19.16%, 29.36%, 25.90%, 33.06%, 26.38% and 22.26% of the students who took SSCE physics exams in 2012, 2013, 2014, 2015, 2016, 2017, and 2018 respectively passed with at least a credit pass. Such abysmal performance is unacceptable considering societal expectations and the huge investments made annually to science education.

Gambari *et al.* (2012); and Biodun (2004) attributed students' poor performance in science subjects, and Physics particularly to poor instructional strategies, lack of qualified teachers, non-availability of standard laboratories, poor infrastructure and poor utilization of instructional aids by teachers. Parents, students, and other stakeholders are pointing accusing fingers of students' mass failure to the teaching effectiveness of science teachers. Past researches have documented various factors that affect the teaching of science subjects in secondary schools. These factors include administration of punishment, class size, poor teaching methods, employment of unqualified science teachers, unavailability of teaching aids, teachers' experience, poor teacher-students' relationship, poor

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teachers' supervision, inadequate classroom management skills, overpopulation of students, and class size (Arop *et al.*, 2018a; Chaman *et al.*, 2014; Effiom and Bassey, 2018; Obiunu, 2015; Ogbonnaya and Osika, 2007; Owan, 2012; Owan and Ekpe, 2018; Owan *et al.*, 2019; Robert and Owan, 2019).

The teaching of science in public schools in Nigeria has witnessed a major setback especially at a time when the desire to promote the development of Science and Technology is looming large. Indeed, the teaching of science subjects such as Physics, Chemistry, Biology, including Mathematics ought to have drifted away from the traditional talk-chalk approach to an approach that provides learners with an opportunity to have hands-on interaction with objects of instruction. Considering governments' huge investment in Education each passing year coupled with the desire to promote sustainable national development, it becomes pertinent to scrutinize the teaching of sciences and explore better innovations that could be used to promote the teaching of science-related courses. The role of teaching aids in enhancing effective instructional delivery of science and other subjects at the secondary school level is not new. Previous researches discovered a significant relationship between the availability/utilisation of teaching aids and effective teaching of science and other subjects in schools (Aina, 2013; Akhihero, 2011; Arop *et al.*, 2015; Malunda and Atwebembeire, 2018; Okpechi and Chiaka, 2017; Richardson and Barnard, 1948; Shukla, 2018).

Advancement in Science and Technology has made the teaching of Science subjects easy for teachers and exciting to students. This is explained by the innovations that are developed to assist science teachers in making abstract lessons concrete. One of such developments is the use of virtual laboratories to facilitate scientific experiments. However, it seems that there is little awareness regarding the use of virtual laboratories in the teaching of science education, in the context of Nigeria. This tends to affect the level of procurement and management of these facilities in schools. This study was undertaken to assess secondary school administrators' extent of awareness, procurement, and management of virtual laboratories to enhance the effective teaching of science subjects.

A virtual laboratory is a relatively new technology that offers practical opportunities for learners where traditional laboratories and teaching methods have failed. Bajpai (2013) sees it as a computer program that allows the student to run simulated experiments via the web or as a standalone application. A virtual lab could be a set of simulations put together (Examples are applets, flash base demons, animations). This allows the students to perform the experiments remotely at any time. Also, experimental-oriented problems can be conducted without the overheads incurred for maintaining science laboratories. A virtual laboratory can be defined as an environment in which experiments are conducted or controlled (partly or wholly) through computer operation, simulation, and/or animation either locally or remotely via the internet. Concerning the computer animation type of virtual laboratories, experiments are often conducted as a graphical model of the actual experiment. This type of virtual laboratories does not include physical hardware, but allow users to observe the process and the end product by way of animation (Chan and Fok, 2015). It often allows users to direct the process and the end product with some controllable variables of the experiment in the software (Oidov *et al.*, 2012).

Introducing and using virtual laboratories in the teaching and learning of science, without a doubt, will bring in new possibilities to motivate and empower students by providing opportunities for independent and experiential learning for them (Oidov *et al.*, 2012). A virtual lab is also particularly useful when some experiments may involve hazardous chemicals and risky equipment. Virtual Lab also is used in systems aiming to replace physical machines with virtual machines on host servers. They eliminate the limitation of physical appearance so that students can complete security exercises on the local operating system utilizing the client/server architecture. Students could manipulate various parameters of the simulations and observed the result. In this approach, there are certain advantages. Bajpai (2013), contends that it is very easy to learn how to use them, the learning objectives are more clearly defined.

Considering the important roles that virtual labs play in the teaching of sciences; it becomes problematic that these facilities are lacking or poorly utilised in schools. Where this problem is observed, blames should be particularly channelled to the school managers. This is because school leaders are saddled with the primary duty of managing human and material resources in schools (Arop *et al.*, 2018b; Arop *et al.*, 2019; Ebuara and Mbon, 2012; Goden *et al.*, 2016; Osim *et al.*, 2012; Owan, 2018; Tampan, 2016; Ukpong *et al.*, 2019). It follows that the duty to liaise with appropriate authorities in the procurement and provision of facilities such as virtual laboratories which are unavailable in schools is of educational managers. It is also the managers' duties to ensure school facilities provided, are effectively managed for longevity, accessibility and active utilisation by teachers. Managers must also ensure that all the necessary support services necessary for virtual laboratories to run smoothly in schools are provided. Thus, science teachers who are unable to utilise virtual laboratories in teaching due to unavailability of virtual laboratories setups should hold their leaders accountable. Science teacher's inability to use instructional resources such as virtual laboratories which are relatively new resources that can help students learn concepts in science subjects could be a great hindrance to students' learning.

Okebukola (2005) stressed that a qualified science teacher (no matter how well-trained) would struggle to make lessons exciting if there is a partial or complete absence of materials necessary to translate competence into reality. Virtual laboratories were designed to address the issue of abstract teaching by making lessons in science education more concrete and pragmatic to students. Empirically, studies have attempted to explain the benefits of using virtual laboratory in teaching science courses (Babateen, 2011; Bajpai, 2013; Barbour and Reeves, 2009; Chan and Fok, 2015; Doukeli, 2012; Efe and Efe, 2011; Falode and Onasanya, 2015; Fischer *et al.*, 2007; George and Kolobe, 2014; Harms, 2000; Harry and Edward, 2005; Kennepohl, 2011; Kerr *et al.*, 2004; Oidov *et al.*, 2012; Tatli and Ayas, 2013). Some researchers have also developed different virtual laboratory programs to assist in the teaching of science subjects. For example, Hashemi *et al.* (2005), developed a virtual materials science laboratory on metallography for tensile testing. The software is fully interactive and its development was based on Macromedia

technologies. It also can provide quizzes and immediate feedback to the users. Similarly, Lee *et al.* (2002) developed a virtual training workshop for ultra-precision machining and inspection facilities. These mimic the real operation of the process, which is something that might not be economically viable in a conventional training workshop.

Other studies have examined the use of virtual laboratories and its relationship to students' learning of science or academic performance in science subjects (Faour and Ayoubi, 2018; Gambari, 2010; Gambari *et al.*, 2012; Mahmoud and Zoltan, 2009; Murniza *et al.*, 2010; Muthusamy *et al.*, 2005; Mutlula and Şeşen, 2015; Tüysüz, 2010). These studies generally, revealed that the utilisation of virtual laboratories significantly affects the teaching, learning, and academic performance of students in science subjects such as Physics, Chemistry, Basic science, and Biology. It is also known from previous studies that virtual laboratory applications made positive effects on students' achievements and attitudes when compared to traditional teaching method (Diwakar *et al.*, 2016). However, one study warned that before virtual laboratories can supersede physical laboratories, they must be adequately supplied and utilised (George and Kolobe, 2014). Then the question arises, how can there be adequate supply and effective utilisation if there is a low level of awareness, procurement, and management of virtual laboratories?

To the researchers' knowledge, no study has in the past, assessed the level of administrators' level of awareness, procurement, or management of virtual laboratories as instructional resources for the teaching of science subjects. A very close study assessed teachers' awareness, accessibility and utilization of computer simulations, virtual laboratories, and virtual field trips in the teaching of physics in Akamkpa Local Government Area, Of Cross River State, Nigeria (Kalu, 2019). Teachers' duty is to utilized and manage virtual labs entrusted to them, while the administrators' roles are to procure, create awareness to teachers, manage virtual labs in schools, and guide science teachers on the approaches to manage virtual labs. All these duties cannot be performed accordingly if administrators themselves are unaware of virtual laboratories, their functions and benefits. The study of Kalu (cited above) cannot be relied upon given its focus on teachers and the small areas of study covered. This study, therefore, was designed to supplement the findings of earlier studies and broaden man's understanding of the extent of administrators' awareness, procurement, and management of virtual laboratories in secondary schools. It was anticipated that the finding of this present study should enable other future researchers to base their studies.

2. Research Questions

The following research questions were raised to guide the study:

- i. To what extent are secondary school administrators aware of virtual laboratories as instructional resources in the teaching of science subjects?
- ii. What is the level of administrators' procurement of virtual laboratories in secondary schools?
- iii. To what extent are available virtual laboratories managed by secondary school administrators?

3. Methods

The study was tailored following a descriptive survey research design. This design was considered in this study to enable the researchers to describe observed phenomena as they occur in the population without any form of manipulation. This study was a case study carried out in public secondary schools in Cross River State, Nigeria. The population of this study covered 667 secondary school managers (271 principals and 396 vice principals). Given the manageable number of elements in the population, the researchers performed a census by integrating the entire population into the study.

Administrators' Awareness, Procurement, and Management of Virtual Laboratories Questionnaire (AAPMVLQ) was used as the tool for obtaining primary data from respondents. APPMVLQ was designed by the researchers and subjected to face and content validity by three psychometric experts and two Science Education Professors all in the Faculty of Education, University of Calabar, Nigeria. It has four sections, 'A', 'B', 'C', and 'D'. Section 'A' was designed to obtain respondents' demographic data; while 'B' was designed with six items (1 – 6) to measure administrators' awareness of virtual laboratories; Section C was designed with six items (7 - 12) measuring administrators' procurement of virtual laboratories; and Section D was also designed with six items (13 – 18) to measure administrators' management of virtual laboratories.

The items in section B–D of APPMVLQ were all organized on a revised four-points Likert Scale for respondents to tick. The reliability of the instrument was determined through the Cronbach Alpha technique, with a coefficient of $\alpha = .83$ proving that the overall questionnaire was internally consistent. Copies of the instrument were administered to the respondents in the respective schools after briefing them on the purpose of the exercise and the need to provide honest responses to the items. Upon completion 662 administered copies were successfully retrieved while five copies of the instrument were not administered as the intended respondents were absent at the time of visitation. Descriptive statistical techniques such as simple percentage, mean, and standard deviation were used to analyse collected data and as well, answer the research questions.

4. Results

4.1. Research Question One

To what extent are secondary school administrators aware of virtual laboratories as instructional resources in the teaching of science subjects? This research question was answered using scores, percentage and mean of the responses of each item measuring administrators' awareness of virtual laboratories in the questionnaire. The results of the analyses are presented in Table 1.

Table-1. Percentage, mean rating, and standard deviation of administrators' awareness of virtual laboratories as resources for teaching science subjects in secondary schools (N = 662)

S/N	Statement	Aware (%)	Unaware (%)	\bar{X}	SD
1	Virtual labs can enable the smooth conduct of laboratory experiments at students' convenience	178 (26.9)	484 (73.1)	2.06	1.015
2	Virtual labs can enable students to redo experiments on the spot while all the results are recorded immediately	178 (26.9)	484 (73.1)	2.04	1.013
3	virtual labs can allow students to easily analyse what went wrong and make adjustments when there are mistakes	173 (26.1)	489 (73.9)	2.03	1.027
4	Schools and students that use virtual labs have access to modern laboratory tools when it comes to experimentation	503 (76.0)	159 (24.0)	2.76	1.626
5	Virtual laboratories enable science teachers to teach in non-stressful conditions	178 (26.9)	484 (73.1)	2.02	1.058
6	Virtual laboratories can be used to supplement the physical science labs in schools	157 (23.7)	505 (76.3)	1.98	.981
	Total	228 (34.4)	434 (65.6)	2.15	1.120
Criterion mean = 2.50					

The results presented in Table 1 disclosed that only 34.4% of secondary school administrators are aware that virtual laboratories can be used as instructional resources in teaching science subjects at the secondary school. On the contrary, 65.6% of secondary school administrators are unaware of the usefulness of virtual laboratories in the teaching of science subjects in secondary schools. The overall mean rating of 2.15 is less than the criterion mean value of 2.50, implying that administrators' level of awareness of virtual labs as instructional resources in teaching science subjects is significantly low. More specifically, many school leaders (73.1%) are not aware that virtual labs can enable students to redo experiments on the spot while all the results are recorded immediately. A higher percentage of administrators (73.9%) are not aware that virtual labs can allow students to easily analyse what went wrong and make adjustments when there are mistakes. Majority of the respondents (76.0) are, however, aware that schools and students that use virtual labs have access to modern laboratory tools when it comes to experimentation. Furthermore, the idea that virtual laboratories enable science teachers to teach in non-stressful conditions is not understood by 73.1% of the respondents. Lastly, 73.6% of educational managers are also unaware that virtual laboratories can be used to supplement the physical science labs in schools.

4.2. Research Question Two

What is the level of administrators' procurement of virtual laboratories in secondary schools? This research question was answered using responses to questionnaire items measuring administrators' procurement of virtual laboratories. The results of the analyses are presented in Table 2.

Table-2. Percentage, mean rating, and standard deviation of administrators' procurement of virtual laboratories in secondary schools (N = 662)

S/N	Statement	Agree (%)	Disagree (%)	\bar{X}	SD
7	There are available virtual labs tools for the teaching of science subjects in my school	160 (24.2)	502 (75.8)	2.00	.986
8	I usually contact government and non-government agencies to support in the provision of virtual labs to my school	163 (24.6)	499 (75.4)	1.97	.966
9	Virtual labs tools for the simulation of science experiments are accessible to science teachers in my school	128 (19.3)	534 (80.7)	2.02	1.028
10	Funds sourced internally are sometimes used to acquire virtual lab tools for the school	176 (26.5)	486 (73.4)	2.01	1.010
11	Many Virtual labs devices available in my school are obsolete	113 (17.1)	549 (82.9)	1.96	.998
12	There are adequate Virtual labs materials to enable different science teachers to conduct experiments simultaneously	125 (18.9)	537 (81.1)	2.00	.995
	Total	144 (21.8)	518 (78.2)	1.99	0.997
Criterion mean = 2.50					

The results in Table 2 indicates that 21.8% of the respondents make efforts to procure virtual laboratory equipment in their schools while 78.2% do not. The level of administrators' procurement of virtual laboratories in secondary schools stood at a mean of 1.99 and a standard deviation of 0.997. The level of procurement of virtual labs by secondary school managers is very low since it is below the expected criterion mean of 2.50. In addition to this result, many school leaders (75.8%) indicated that virtual labs tools for the teaching of science subjects are not available in their schools. A higher percentage (75.6%) of the respondents indicated that they do not contact government and non-government agencies to support in the provision of virtual labs to their schools. Only 19.3% of the respondents showed that virtual labs are accessible to science teachers in their schools. Only 26.5% of secondary school managers used internally generated funds to procure virtual lab tools for their schools. More so, a meagre 17.1% of the respondents indicated that virtual lab devices available in their schools are obsolete. Finally, only 18.9% of secondary school administrators revealed that are adequate virtual labs materials that will enable different science teachers to conduct experiments simultaneously.

4.3. Research Question Three

To what extent are available virtual laboratories managed by secondary school administrators? This research question was answered using responses of the 160 administrators who indicated that virtual laboratories are available in their schools. This was done to obtain information from them regarding the ways they manage these labs in their schools. Thus, responses of participants who indicated that there are no available virtual labs in their schools were not treated in this section. As they cannot manage what is not available in their schools. Simple percentage, mean and standard deviation as descriptive statistical techniques were used to analyse responses. The results of the analyses are presented in Table 3.

Table-3. Percentage, mean rating, and standard deviation of administrators' management of virtual laboratories in secondary schools (N = 160)

S/N	Statement	Agree (%)	Disagree (%)	\bar{X}	SD
13	The available science virtual laboratories in my school are in good working conditions	38 (24.0)	122 (76.0)	1.99	.961
14	Efforts are usually made to check installed virtual labs programs for damages	39 (24.5)	121 (75.5)	2.00	.991
15	The rooms hosting virtual labs are regularly kept free from dust and dirt	117 (73.4)	43 (26.6)	2.04	1.021
16	I ensure that there is an immediate replacement of damaged virtual labs programs	40 (24.8)	120 (75.2)	1.96	1.004
17	I check for updates weekly to ascertain whether new versions of virtual labs software are available	38 (23.9)	122 (76.1)	2.00	.983
18	Internet services in my school are managed to offer full support to virtual labs.	43 (26.7)	117 (73.3)	2.06	1.025
	Average	53 (33.1)	107 (66.9)	2.01	0.998
Criterion mean = 2.50					

As shown in Table 3, the results of the analysis indicated that a higher percentage of secondary administrators (66.9%) are not managing available virtual laboratories. Only 33.1% of secondary school managers engage in the management of virtual laboratories in their schools. The grand mean value of 2.01 is less than the estimated criterion mean value of 2.50, suggesting that the average management practices of secondary school administrators towards virtual laboratories is significantly low. In specific terms, only 24% of the respondents indicate that available science virtual laboratories in their schools are in good working conditions. Also, 75.5% of secondary school managers do not make efforts to check installed virtual labs programs for damages. However, 73.4% of the respondents indicated that they take proper care of the rooms hosting virtual labs. Meanwhile, 75.2% of the administrators do not ensure that there is an immediate replacement of damaged virtual labs programs. For new versions of virtual labs, only 23.9% of secondary school leaders indicated that they check for software updates only a weekly basis. Lastly, 73.3% of secondary school principals do not manage internet services in their schools to offer full support to virtual labs.

5. Discussion of Findings

This study revealed that there is a low level of awareness by secondary school administrators that virtual laboratories are instructional resources that can aid the teaching of science subjects. This low level of awareness may be attributed to poor provision of modern facilities to secondary schools which have made them unavailable. Perhaps the majority of the secondary school principals are not science-oriented, hence the low level of awareness. This finding tallies with the results of Kalu (2019) which showed that the level of teachers, awareness, accessibility, and utilisation of computer simulations, virtual laboratories, and virtual field trips is significantly low. Who knows, maybe the low level of teachers' awareness, accessibility, and utilisation discovered by Kalu (2019) was due to the low level of awareness, procurement, and procurement of virtual labs by school leaders uncovered in the present. Further investigation is necessary to study the effect of administrators' awareness and procurement on teachers' awareness and utilisation of virtual labs.

It was also shown in the study that many secondary school administrators do not engage in activities that promote the procurement of virtual laboratories to their schools. This may be attributed to their low level of awareness of the existence and/or functions of virtual labs in the field of sciences. Thus, they cannot procure what they do not even know exists. Another reason may be due to the total reliance on the government for the provision of every school facility without sourcing for alternative channels of funding. The second finding of this study implies that the postulation made by Okebukola (2005) that a qualified science teacher (no matter how well-trained) would struggle to make lessons exciting if there is a partial or complete absence of materials necessary to translate competence into reality. Thus, science lessons cannot be made concrete if materials required to do so are not procured by those in charge of doing so.

Lastly, it was shown that there is a low extent of administrators' management of virtual laboratories in secondary schools. This finding is unsurprising because virtual labs cannot be managed where they are unavailable. The low level of awareness, which hindered procurement and availability, may have also hindered the management of these vital resources for the teaching of science subjects. Based on the position of the third finding of this study, the benefits of using virtual laboratories outlined/discussed by previous studies (Babateen, 2011; Bajpai, 2013; Barbour and Reeves, 2009; Chan and Fok, 2015; Doukeli, 2012; Efe and Efe, 2011; Falode and Onasanya, 2015; Fischer *et al.*, 2007; George and Kolobe, 2014; Harms, 2000; Harry and Edward, 2005; Kennepohl, 2011; Kerr *et al.*, 2004; Oidov *et al.*, 2012; Tatli and Ayas, 2013) will be a mirage, if school administrators do not manage them effectively.

6. Conclusion

It was concluded generally, on the premise of the findings of the study that, the level of awareness, procurement, and management of virtual laboratories by secondary school administrators is very low. This affects and will continue to affect the teaching of science subjects at the secondary school level. Therefore, urgent attention has to be paid to this area, especially in an era where technology drives the activities of man. The poor academic performance of students in science subjects could also be liberated if lessons are made more experiential. Thus, the procurement, management, and above all, utilisation of virtual labs could help in the attainment of this goal in the future.

Recommendations

Based on the conclusion, this study recommends that:

- i. The Science Teachers Association of Nigeria (STAN) should design a workshop for all secondary school administrators and science teachers to update their knowledge on trends and innovations in sciences.
- ii. The government at all levels should make swift efforts in the provision of virtual laboratory tools for every science subject taught in schools.
- iii. Secondary school principals should sometimes use internally generated or funds from external donors to procure/manage new/existing virtual laboratory for/in their schools.

7. Limitations

Based on the scope of this study, it was not possible to show the causes of administrators' low level of awareness of virtual laboratories as instructional resources for the teaching of science subjects. This calls for future studies to focus more on this area. The researchers only speculated that the discipline (area of speciality) of secondary school principals may have caused a low level of awareness without any evidence backed by data, this opens up another gap for an empirical survey to be undertaken in the future in this regard. The sample of administrators used in the study was drawn from only one State in Nigeria, limiting the level of generalisation to that extent. This calls for a broader study at the regional and national level or across international borders for better generalisations.

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