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Future of Remote Learning: The Virtual Laboratory Perspective

[1]Ndunagu, J. N., [2]Ukwandu, E., [3]Ezema, M. E., [4]Olebara, C., [5]Ugwu, C. I., [6]Igwe, J. S., [7]Oyewola, D. O. & [8]Fapohunda, S. E.

1: National Open University of Nigeria (NOUN)
jndunagu@noun.edu.ng,
2. Cardiff Metropolitan University, Cardiff, Wales, United Kingdom
eaukwandu@cardiffmet.ac.uk
3: University of Nigeria Nsukka (UNN)
modesta.ezema@unn.edu.ng
4: Imo State University
5: University of Nigeria Nsukka (UNN)
celestine.ugwu@unn.edu.ng
6: Ebonyi State University, (EBSU) Abakaliki
igwejoesun@ebsu.edu.ng
7: Federal University Kashere, Gombe State
davidakaprof01@yahoo.com
8: National Open University of Nigeria (NOUN)
seyifapohunda@yahoo.com

Abstract

This study examined the viability of using a virtual laboratory as an alternative to the traditional technique of performing experiments in an open and remote learning environment. A Google form was utilised to gather information from National Open University of Nigeria (NOUN) science students through an online questionnaire. A total of 350 students were recruited from six Study Centers of NOUN each from the geographical zone based on four faculties using convenience sampling. The students' WhatsApp numbers were used to circulate the questionnaire. Statistical Packages for Social Sciences (SPSS) was used to analyse the responses which were coded in a spreadsheet (SPSS). All dependent factors provided by participants were tested using the Chi Square test for demographic variables (age, gender, and field of study). With a p-value of 0.006, the results revealed a statistically significant relationship between age and demand for alternative virtual laboratory usage. There was statistical significance found between the faculty of study and the demand for high-speed Internet. The findings revealed that the current NOUN Practical teaching technique is insufficient since it has no relationship with any of the independent variables. NOUN, which already operates physical laboratories in zonal centres, might supplement the Practical Teaching Technique with a virtual practical learning system that simulates real-life practical sessions. The outcome improved internet access along with a hybrid of both physical and virtual practical learning that would address the NEEDS of NOUN students as identified in the NEEDs assessment survey and would reduce the attrition rate of science students.

Keywords: *Virtual laboratory, Hybrid learning, Remote learning, Open and Distance Learning, Face-to-Face, Traditional learning*

1. Introduction

Knowledge is power and information must be presented in such a manner that may be deemed complete in order for the learner to assimilate and pass it on to others. Learning becomes difficult when it is remotely expressed with a particular focus on laboratory experiments.

Cyber-Ranges is a virtual simulated environment for practical hands-on training of cyber-security professionals, students and learners in cyber-threat protection and situational awareness, has shown to be extremely effective and has a broad variety of applications. The platform has been found to assist in instilling a better awareness of

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the progression of cyber-related assaults, as well as possessing the necessary approach for implementing the most effective defenses to stop breaches [1]. The development of virtual simulated laboratory scenarios and use cases that can be used in practical training of students and learners in Computer Science programmes in an Open and Distance Learning (ODL) environment is proposed based on the success of using Cyber-Ranges in conducting virtual laboratory trainings in cyber-security.

ODL is a type of education based on distance learning in which students study remotely rather than attending conventional face-to-face sessions. The need for ODL possibilities, particularly in emerging nations such as Nigeria, is immense and vital to deal with the country's population expansion [2].

The employment of Information and Communication Technologies (ICTs) in ODL institutions bridges the gap between facilitators and learners. Learning is offered asynchronously or synchronously at ODL institutions, depending on the learning objectives and technology available with various noticeable advantages. First with the potential to reach new and previously under-represented student demographics, the flexibility to adapt and alter to fit individual needs and the opportunity to be inventive remotely inside the classroom are all important [3]. Secondly, since most ODL activities are virtual and many school structures are not necessary in terms of cost. Thirdly, ODL is adaptable; students may work and study at the same time, and they can learn at their own speed. Fourthly, it can function across great distances and serves students from all around the world [4]. Institutions that provide Open and Distance Learning (ODL) make teaching and learning more flexible because both single mode and dual mode institutions that specialize in distant learning are available via ODL.

Single mode Open universities have grown in popularity over the years, and they account for the majority of the world's "mega-universities" (those with more than 100,000 students). The University of South Africa, Germany Fern Universität, the United Kingdom Open University, Korea National Open University, the Arab Open University, Cyprus Open University, Malaysia Wawasan Open University, and National Open University of Nigeria (NOUN) are all single-mode institutions.

NOUN is a giant university with over 500,000 students spread over 103 study centres in 36 Nigerian states and Abuja Capital City. Four of the eight faculties are scientific-based and laboratory practical are compulsory for science students to graduate. In education, laboratories are good places for students to practice ideas by doing [5].

The laboratory is an essential aspect of education, particularly in practical subjects such as engineering and science which need hands-on experience and its job is to achieve a balance between theory and practice [6]. Laboratory work improves students' interest and positive attitude toward science [7], and it is a requirement for science students to graduate. Setting up a laboratory is both costly and time-consuming, and just teaching students the theory of the disciplines is insufficient to ensure that they fully comprehend the ideas [5].

With the ODL dispersed character, it would be impossible to teach practical skills at ODL institutions [2]. ODL, according to [8], should develop and offer remote courses that emphasize field-based and experiential learning. The challenge of teaching laboratory components is exacerbated at NOUN since it will be very difficult to duplicate laboratories across the university's 103 study centres because laboratory activities are costly and time-consuming [9]. The "Mobile Laboratory" is the name for NOUN practical form of hands-on practical for science students.

The exercises are done in host centres for each state of the six geographical zones of the country while other centres from other states of the geopolitical zone convene at the host centre. The current method of teaching practical (Mobile Laboratory) in NOUN has many challenges, among which is poor turnout during the exercise, this has made it difficult to have the scores from the Mobile Laboratory exercise mandatory for all students.

The necessity for this article arose from the issues faced by both students and NOUN administration about the practicability of having physical laboratory practical for science-based students. This report uses stakeholder surveys in six study centers to analyze existing practical processes and the needs/expectations of learners and facilitators in order to generate simulated practical situations for NOUN's Science-based curriculum.

2. Related Works

2.1 Distance Learning: The Impact of Learning Management System (LMS)

The ODL is a type of education in which students learn remotely rather than in a regular classroom setting [2]. Open and Distance Learning (ODL) is a style of learning that focuses on the learner (Learner- Centered). ODL is also known as "Self-Learning," "Independent Learning," and "Flexible Learning" [10]. The major goal of ODL is to achieve educational equality via diverse types of education. The teaching of laboratory components is one of the most difficult aspects of open and distance learning. Physical laboratories will be difficult to operate in ODL institutions due to the diverse spread of learners' locations, according to [2].

As a result, virtual laboratories are suggested because ODL institutions already facilitate courses virtually and thus have the necessary platform for Learning in a Virtual Environment. (LVE). A Learning Management System (LMS) is also known as a Virtual Learning Environment (VLE), a Virtual Learning System (VLS), a learning platform, or an e-learning portal (LMS). A Learning Management System (LMS) is a software application that manages, documents, tracks, reports, automates, and delivers educational courses, training programmes, learning and development programmes.

According to Aldiab *et al.* [11], all LMS systems rely entirely on current Information and Communication Technology (ICT) infrastructure and computer technologies to operate. First Class, which was established by SoftArc in 1990, was the first LMS software. This was client-server software with some helpful capabilities including email, a message board, and online meetings. First Class ran on a variety of operating systems, including Windows, Linux, and macOS. As a consequence of open competition, several sophisticated LMSs arrived after that date. Blackboard LLC, created by Michael Chasen and Matthew Pittinsk in 1997, is one of these LMSs. Moodle, which was developed in 2001 by Martin Dougiamas, Canvas, which was founded in 2008 by Josh Coates, and D2L, also known as Desire2Learn, which was founded in 1999 by John Baker.

Moodle, Edmodo Desire2Learn, Blackboard by Angel and WebCT, Instructure Canvas, Sakai, and Pearson Learning Studio are the most used LMS software [12]. Each is unique and offers users a variety of implementation options, including content-oriented, activity-oriented, network-oriented, linear, and branching. Some systems allow for asynchronous instructions, whereas others only allow for synchronous ones.

Learning Management System, according to Muhardi et *al.* [13], is a solution to the many issues that develop as a result of restricted time, location, and number of interactions between instructor and student. As a tool in the learning process, the Learning Management System has various benefits, including the ability to tackle difficulties that emerge often throughout the learning process. They go on to say that the Learning Management System application is a good support for learning activities since schools can do more than just educate in the classroom.

Alfarsi *et al.* [14] defined learning system management as the fundamental challenge in developing learning abilities and enhancing students' learning performance. Students have difficulty studying through standard techniques and regular activities, which reflects their academic level. LMSs, which are broadly defined as information systems that facilitate e-learning by supporting teaching and learning, but can also perform administrative tasks and facilitate communication between facilitators and learners, are now commonplace in higher education for both on-campus and distance students.

According to Holmes and Prieto-Rodriguez, [15], the accessible teaching materials in university settings have evolved drastically in recent years, from chalk, blackboards, and overhead projectors to Learning Management Systems (LMS). LMSs, which are broadly defined as information systems that facilitate e-learning by supporting teaching and learning, but can also perform administrative tasks and facilitate communication between facilitators and learners, are now commonplace in higher education for both on-campus and distance students. However, LMS systems have been criticised for being excessively instructor-centric, since they seem to mainly assist instructors to boost their efficiency in dealing with student assignments and feedback, as well as the distribution of teaching materials and related administrative responsibilities. In contrast to classic transmission models, LMS have lately begun to add interactive tools like as blogs, wikis, chat rooms, and discussion platforms; characteristics that have the potential to encourage constructivist approaches to learning.

2.1.1 Learning Management System Characteristics

According to Aldiab *et al.* [11], LMSs provide several advantages for educational processes. The notion of disregarding the actual location is the first characteristic. Students from the same institution who are studying on separate campuses might utilise LMS as an efficient tool. Some institutions have many campuses, which might include national and international campuses, each with its own time zone. The LMS is used to bring all of these students together in one virtual space, boosting their interactions, conversations, and feedback. In fact, using LMSs or eLearning is beneficial for all students, but especially for those who face challenges such as living outside of the original physical campus (rural areas or another country) or having health issues, because it provides a continuous educational process regardless of location or time.

Remote Learning is made up of numerous ideas, the most important of which are the platform for remote learning, student behaviour, and instructor conduct. The Learning Management System (LMS) must have a number of strong software attributes in order for remote learning to be effective. Reliability, Usability, Scalability, Security, Innovation, and Time-to-Market are some of the attributes that are considered software development factors.

2.1.2 Learning Management System Users

According to Ak *et al.* [16], the LMS system defines three separate users. These are they:
a. Trainee: Trainees are merely required to attend lectures, tests, and practices, as well as schedule experiments.

b. Instructor: In the course module, they can add lessons to the system, and in the exam module, they can add questions and answers to the test pool. They may watch the experiment live and tamper with it if they like in the experiment module.

c. Administrator: The administrator (Admin) may delegate authority to the instructors, question course participants' progress, and track trainee development based on test results. The certificate of success is also prepared by the administration.

According to Sus *et al.* [12], there are two sorts of LMS: free and commercial, each with its own set of benefits and drawbacks. LMS may be installed on a company's server or as a Software-as-a Service (SaaS) solution that is hosted on the vendor's servers and accessible from anywhere (data is saved in "the cloud"). NOUN, an ODL university, already uses the Learning Content Management System (LCMS) for synchronous and asynchronous learning, and LCMS may be utilized for virtual laboratory hosting if chosen.

2.1.3 Learning Modes: Asynchronous and Synchronous

Asynchronous and Synchronous are learning paradigms that may be used to enable Open and Distance Learning in a variety of networked e-learning systems and applications (ODL) (See Table 1). They function as virtual learning environments (VLE). The nature of the learning challenge determines whether synchronous or asynchronous components are used. Synchronous learning environments involve simultaneous student-teacher presence and enable real-time engagement, which may be collaborative in nature including e-activities [17] such as an instructor's lecture with a facility for questions-answer sessions.

Asynchronous environments are not time constrained, allowing learners to complete e-activities at their own speed. With the use of synchronous sessions, distance in remote education is minimized [18]. Because of its flexibility, asynchronous learning or teaching has become the most popular modality of online instruction [19]. Students in asynchronous settings have access to information such as audio/video lectures, handouts, articles, and power point presentations. This information is available via a Learning Management System (LMS) or a Learning Content Management System (LCMS) at any time and from anywhere. Like a classroom, a learning management system

(LMS) or learning content management system (LCMS) holds course information and offers a framework for communication between students and instructors. Because learners are not timed and may react at their leisure, asynchronous e-learning is the most widely used approach for online education [20]. Because they may ponder about an issue for a long amount of time and develop divergent thinking, the option of delayed response helps them to apply their higher order learning abilities.

A manufactured answer replaces spontaneity of expression in the asynchronous way of learning. As a result, asynchronous space promotes self-directed, autonomous, and student-centered learning [21]. As a result, asynchronous e-learning may build on students' prior knowledge by introducing new ideas [22]. Less dependence on memory and notes, as well as greater opportunities for peer group conversations, aid critical thinking and deep learning [23]. The facilitators' nervousness is alleviated by the distance mode, which reduces shyness.

The emotional filter stays low since there is less pressure than in a real-time interaction, allowing learners to react more innovatively and imaginatively. Because there is adequate time to try e-activities, the possibilities of being frustrated by technical problems - such as poor speed and non-connectivity - are minimal. Asynchronous e-learning may be difficult to keep students engaged and interested in since only a well-developed set of tactics can support motivation, confidence, involvement, problem solving, analytical, and higher order thinking abilities in this kind of learning environment. Furthermore, it is a self-paced system in which learners must be self-disciplined in order to be engaged and engaging in order to maintain track of e-activities. While interactions on forums and blogs might keep children engaged, deviating from the subject can also be distracting. Another aggravating issue is delayed feedback [23]. Furthermore, there are limited possibilities for socializing, forcing students to create their own networks.

Synchronous e-learning, on the other hand, refers to simultaneous learning or teaching through an electronic medium. Facilitators–learners and learner–learner contact is possible in synchronous voice or text chat rooms. Video-conferencing, in addition to chat, allows for face-to-face contact. Surveys, polls, and question-and-answer sessions may make web conferences more participatory than video conferencing. Through collaborative learning, synchronous mode fosters a feeling of community.

Asynchronous virtual classrooms allow teachers and students to communicate and engage in real time. It mimics a regular classroom, with cameras and class discussion elements, except that all participants access it remotely over the Internet. Lessons may be recorded and stored electronically. Students may view and repeat facilitator's lectures as many times as they need to master the content using the archived e-library. Direct real-time engagement with facilitators and learners is extremely similar to a regular face-to-face classroom, if not better, since distance is no longer an issue and no time is lost commuting thanks to Internet access.

Due to the presence of the facilitator and classmates, synchronous sessions might result in high levels of desire to remain involved in e-activities. During synchronous style of learning, problems encountered in learning may be rectified with fast feedback and responses. Learners may use facial expressions and voice tones to have a more human experience and engage in global engagement without spending a lot of money.

Some of the obstacles of synchronous education include the necessity for students to be available at a certain time and the need for enough internet connection. Due of technological difficulties, participants may feel disappointed and thwarted. Furthermore, since pedagogy is more essential than technologically aided media, a well developed instructional design is necessary [21], for example, believe synchronous mode to be more facilitator - oriented. To expand the scope of synchronous communication beyond a lecture or facilitator - learner interaction solely, special e-activities must be developed.

Table 1: Asynchronous vs Synchronous Distance Learning [24]

	Synchronous	Asynchronous
Model	Teacher and students interact with each other in real - time	The teacher delivers the instruction via video, computer and other means while students respond at later time
Technology	Videoconferencing , Audio conferencing, Internet Chat, Whiteboard	Video Tape, CD ROM, Broadcast video, email , www courses
Example	Using a two-way video conferencing tool, students interact with live video of an instructor	Instruction may be delivered via web and the feedback could be sent via email.

2.2 Technology Acceptance Model (TAM)

TAM is a paradigm for how people adopt and utilize new technology in information systems. Fred Davis created the theory in 1989, and it is based on a theory originally defined by [25]. The Theory of Reasoned Action (TRA; [26] was developed from Fishbein's theory. Three equations are proposed by TRA for gauging behaviour and attitude toward a certain activity.

Three ideologies are presented in this theory:
1. There is a causal link between the execution of a planned behaviour and the actual performance of that behaviour.
2. An individual's attitude toward a particular conduct is a function of the behavior's seen consequences multiplied by the consequences' assessments.
3. The subjective standard of an individual is determined by "perceived expectations of certain referent persons or groups, as well as the person's drive to meet those expectations" [26].

Three equations were used to represent these philosophies. TAM was designed as a method for assessing attitude toward technology usage based on the Fishbein hypothesis.

2.2.1 Hypothesis and Model Ideology

TAM's theoretical framework is shown in Figure 1. Variables X1, X2, and X3 are different design aspects of a new technology like a SaaS system, such as a remote learning app, email, social networking site, video conferencing site, and so on).

2.2.2 The Hypothesis of the Model:

The design aspects of a technical system affect a user's attitude toward that system. As a result, design aspects impact "perceived utility and ease-of-use," which in turn influence attitude toward usage. Finally, "attitude toward use" determines how the technology is used. Figure 1 depicts the TAM model:

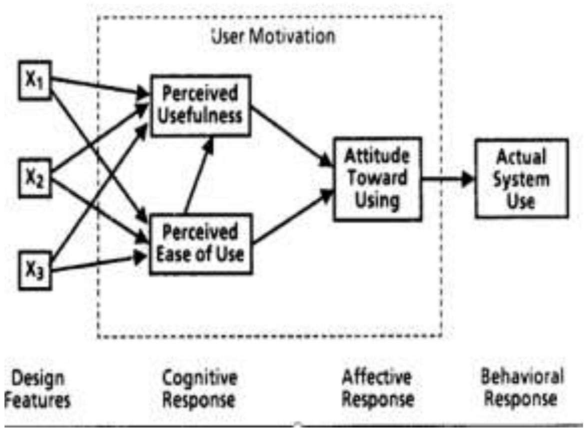

Fig. 1: Technology Acceptance Model (TAM) [27]

2.2.3 Equations Representing Variables in TAM Model

TAM specification for the four variables is represented using the equations below:

Eqn 1-----EOU = $\sum_i = 1,n \ \beta_i X_i + \varepsilon$
Eqn2--USEF = $\sum_i = 1,n \ \beta_i X_i + \beta_{n+1}$ EOU + ε
Eqn3-----ATT = β_1 EOU + β_2 USEF + ε
Eqn4----- USE = β_1 ATT + ε
Where
X_I = Design features i,i = 1,n
EOU = Ease of Use
USEF = Perceived usefulness

Variables Definition:
1. **Perceived ease of use**: users believe that acquired technology will be understandable, interactive, user friendly, and with less clicks.

TAM uses multi-item (10-item) survey question to address this. Respondents are required to self-report their belief using a 7-point scale Likert scale:

Strongly Agree Neutral Strongly Disagree
1 2 3 4
5 6 7

2. **Perceived Usefulness**: defined as the degree to which an individual believes that using a particular product or system would enhance his/her job performance. This variable also has multi-item survey questions(10-items) and also uses 7-point Likert scale to evaluate responses for participants.

Strongly Agree Neutral Strongly Disagree
1 2 3 4
5 6 7

3. **Attitude towards using**: TAM measures the level to which an individual associates with using the technology in his or her job. A multi-item survey question is suggested also (5-items) to which respondents answered using a 7-point semantic differential rating scale developed by [28].

Good:______: _______: _______: _______: _______: _______: _______Bad.

4. The fourth variable "actual system use" is measured using two items in the survey form. The first item is a question that measures frequency of system use, while the second item measures the amount of time.

It is common knowledge that laboratory work is an essential component of engineering and scientific curricula at both the university and secondary levels. The laboratory aids in the development of high level technical, communication, and teamwork skills in support of applicable classroom theories by providing hands-on experience with equipment. One of the main aims of every new technology is to make cutting-edge technologies accessible to low-income people. This is quite useful for creating a virtual laboratory environment.

The ability to give learners with access to laboratory facilities at any time and from any location is an extra benefit. The additional benefit comes in the form of reduced travel costs and related dangers. Physical laboratories are only available on a limited basis and may be out of reach for low-income universities. To address the actual challenges of costly industrial equipment that cannot be relocated or replicated, a virtual laboratory may be accessed remotely. Mayoz *et al.* [29] identified many issues with using scientific equipment in the classroom, including availability and related expenses of acquisition and maintenance.

In contrast to working in physical labs, students are increasingly realising that utilising virtual laboratories would enhance their learning experience. Working in distant labs saves money by providing a safe, multinational, multicultural atmosphere that would have cost a lot of money otherwise. In the age of globalisation and coronavirus, all of these are becoming more essential.

Real, virtual, and remote laboratories are the three types of laboratories. Instead of direct replacement, they may be blended to complement each other. This is because each variety has advantages and disadvantages.

Despite the fact that web-based labs give students with experimental training, they are also an effective teaching tool since real-time demonstrations of the experiments may be done. A remote laboratory allows groups of students to observe the experiment in real time. This has an incalculable cost worth. Because materials can be shared through the Internet, this strategy is especially advantageous for engineering schools in impoverished nations.

A Review of the Virtual Laboratory Development Approach

Venant *et al.* [30] aimed to improve the educational aspects of virtual and remote laboratories. This was accomplished by creating a set of awareness and reflection activities that may engage participants in the deep learning process during a remote practical session. The developed tools were seamlessly incorporated into the Lab4CE remote laboratory environment, and the resultant integration was tested in a real-world learning scenario. The results of an experiment with 80 students revealed that the participants rated the system marginally better than traditional computational environments in terms of leveraging reflection and critical thinking.

A technological architecture was proposed to address the complexities of integrating laboratory exercises into a learning management system [31]. The suggested architecture makes advantage of the Web Services standard to provide a basic session authentication method for the client browser sending the request, as well as a simple Web Services request forwarding module inside the LMS system.

To improve student follow-up and learning experience, a novel approach was presented to interoperate Learning Management Systems (LMS) and Remote Laboratories [32]. A loosely connected solution was designed, based on existing software, that enables a collection of widgets to be hosted in the LMS and utilized for Remote Laboratories (RLabs) sessions. The RLabs were created by instantiating widgets obtained from the LMS, resulting in interoperability between the LMS and RLabs. The most important concerns and developments in virtual labs (simulation environment laboratories and remote laboratories) were presented through the internet [33].

In Mayoz *et al.* [29], a cross-national remote laboratory with 17 devices was demonstrated to offer students from the participating universities access to the laboratory. The lab was set up at UPNA in Spain and UNIFESP in Brazil, with Labs-Land providing the technology and administration. The laboratories offered automated fault tolerance and enhanced the number of possible students by allowing both universities to use the labs at the same time.

A flexible and powerful virtual X-ray laboratory for Materials Science and Engineering was created to familiarize both undergraduate and graduate students with the design and operation of X-ray equipment in visual and interactive ways in order to learn fundamental principles underlying X-ray analytical methods [34]. Students were able to conduct authentic online experiments, complete homework and control assignments in traditional and blended courses, prepare for hands-on work in physical X-ray labs, observe lecture demonstrations, and be evaluated in terms of performance using virtual equipment and laboratory assignments. Instructors were able to monitor students' progress using the accompanying learning and content management system (LCMS) and writing tools, as well as create new virtual experiments and more tailored learning assignments for them.

To address the issue of students' incapacity to execute particular competence abilities, as well as difficulties discovered during the implementation of the 2013 curriculum, a virtual laboratory was created in Masril *et al.* [35] to improve physics concepts knowledge. The study used a four-dimensional model for research method development (definition phase, design phase, development phase and dissemination phase).

3. Methodology

3.1 Research Purpose and Design

This is an exploratory research to see how NOUN students feel about the current delivery style of practical laboratory courses. It also use an open-ended questioning technique to get user NEEDS from students in order to create and construct a practical laboratory teaching system that would enhance learning outcomes.

3.2 Research Area

NOUN scientific students from four faculties, namely Agriculture, Education, Health Sciences, and Sciences, were the target audiences. Data was gathered from six research centres spread throughout six geopolitical zones and 36 states, with one study centre from each geopolitical zone. Lagos Study Centre (South West Zone), Owerri Study Centre (South East Zone), Uyo Study Centre (South South Zone), Abuja Model Study Centre (North Central Zone), Kaduna Study Centre (North East Zone), and Maiduguri Study Centre (North East Zone) are the study centres chosen (North West Zone). The online survey received 350 responses.

3.3 Participants and Methodology

To acquire data from NOUN students, this study employed an online survey created using Google Forms (Undergraduates and Post graduates). The students' WhatsApp social media channel was used to disseminate the questionnaire. A total of 350 people completed the online survey, and the results were incorporated in the final analysis. The questionnaire was divided into four parts, each with open-ended and closed-ended questions.

3.4 Hypotheses and Research Questions

For the study, the following research questions and hypotheses were posed:

Questions for Research
1. Will the current NOUN Remote Learning system assist in the implementation of the planned Virtual Laboratory System?
2. Are NOUN students prepared to use Virtual Lab?

Hypotheses
1. H1: NOUN's current remote learning system qualifies it to participate in a virtual laboratory.
2. H1: NOUN students are willing to use the virtual laboratory system.

3.5. Data Evaluation

Statistical Packages for Social Sciences was used to analyze the responses, which were coded in a spreadsheet (SPSS). The frequency distribution of demographic items was shown using descriptive statistics. The Chi Square test was also used to test the independent variables. Chi Square evaluates the relationship between demographic variables such as age, gender, and field of study, as well as a response variable that represents the students' indicated NEEDs. Each of the 350 responders recommended three different approaches to arrange practical instruction, totaling almost 900 options. Participants' responses were divided into 18 subgroups and assigned to these four groups for the Chi Square test. See table 2 for the study’s Socio Demographic Frequency.

4. Results and Discussion
4.1 Results

Table 2: Socio-Demographic Frequency

S/N	Variables	Frequency	Percentage
1,	Gender		
	Male	140	40
	Female	210	60
	Total	350	100
2.	Age		
	17-19	9	2.6
	20-22	35	10.0
	23-25	41	11.7
	>25	265	75.7
	Total	350	100
3.	Are you working and studying		
	No	45	12.9
	Indifferent	13	3.7
	Yes	292	83.4
	Total	350	100
4.	Faculty		
	Arts	2	0.6
	Science	304	86.8
	Engineering	1	0.3
	Others	43	12.3
	Total	350	100
5.	Present NOUN Practical Teaching		
	Physical/Face-to-face	349	99.7
	Missing System	1	0.3
	Total	350	100

Frequency distribution of suggestions on how students want NOUN practical teaching to be structured shows that majority 168 (48.4%) of the students want a continuation of face-to-face method. Arguments include non-feasibility of a stand-alone virtual system which they attributed to infeasibility of departments such as Chemistry understanding chemical reaction virtually, cost of data, incessant of power outages. This school of thought therefore requested: Study center based practical laboratory, Collaboration with established Institutions for use of their facilities, and presentation - based teaching.

Following this group are participants who suggest that virtual learning will be more beneficial (98(28.2%)), while requesting for stronger internet coverage (23(6.6%)), and Qualified resource persons (30(8.6%)). A third major group suggests a hybrid of Traditional face-to-face and virtual 39participants (11.1%) belong to this subgroup. See Tables 3 to 6 showing the following: the Study’s Frequency Distribution of subgroups, Chi Square showing Cross-Tab of Age and NEEDs variables, Chi Square showing Cross-Tab of Gender and NEEDs variables and Chi Square showing Cross -Tab of Gender and NEEDs variables.

Table 3: Frequency Distribution of subgroups Source: SPSS Analysis output

S/N	DEPENDENT VARIABLE (User Defined NEEDS on how NOUN Practical Teaching should be structured)	Frequency	Percentage 98
1	Virtual Lab	98	28.2
	Physical Lab	168	48.4
	Teach with Presentation applications	8	2.3
	Free/Low cost internet	8	2.3
	Higher Practical grading	4	1.1
	Collaboration with other Universities	4	1.1
	Employ Qualified resource persons	30	8.6
	Study Groups	7	2.0
	Curriculum Development	1	0.3
	Teacher training	2	0.6
	Record and burn to CD	6	1.7
	Longer practical sessions	9	2.6
	Make it Cost Effective	4	1.1
	Provide Strong internet coverage	23	6.6
	Practical should be on weekends	6	1.7
	Students should be notified of fixed practical sessions	1	0.3
	No idea	39	11.1
	Blended	39	11.1

Table 4: Chi Square showing Cross-Tab of Age and NEEDs variables Source: SPSS OUPUT

S/N	INDEPEN-DENT VARIABLE	DEPEN-DENT VARIABLE (User Defined NEEDS on how NOUN Practical Teaching should be structured)	Asymp. Sig	Chi Square
1	Age	Virtual Lab	0.006	12.500
		Physical Lab	0.56	2.061
		Teach with Presentation applications	0.762	1.162
		Free/Low cost internet	0.247	4.140
		Higher Practical grading	0.777	1.101
		Collaboration with other Universities	0.732	1.288
		Employ Qualified resource persons	0.509	2.321
		Study Groups	0.371	3.137
		Curriculum Development	0.57	7.509
		Teacher training	-	-
		Record and burn to CD	0.820	0.923
		Longer practical sessions	0.083	6.681
		Make it Cost Effective	0.673	1.542
		Provide Strong internet coverage	0.150	5.312
		Practical should be on weekends	0.584	1.943
		Students should be notified of	0.26	9.262

		fixed practical sessions		
		No idea	-	-
		Missing data	-	-

Table 5: Chi Square showing Cross-Tab of Gender and NEEDs variables Source: SPSS Output

S/N	INDEPENDENT VARIABLE	DEPENDENT VARIABLE (User Defined NEEDS on how NOUN Practical Teaching should be structured)	Asymp. Sig	Chi Square
1	Gender	Virtual Lab	0.702	0.146
		Physical Lab	0.206	1.602
		Teach with Presentation applications	0.194	1.689
		Free/Low cost internet	0.374	0.790
		Higher Practical grading	0.532	0.390
		Collaboration with other Universities	0.14	6.012
		Employ Qualified resource persons	0.232	1.429
		Study Groups	0.525	0.404
		Curriculum Development	0.411	0.675
		Teacher training	-	-
		Record and burn to CD	0.183	1.775
		Longer practical sessions	0.794	0.068
		Make it Cost Effective	0.099	2.724
		Provide Strong internet coverage	0.911	0.12
		Practical should be on weekends	0.30	4.717
		Students should be notified of fixed practical sessions	0.222	1.490
		No idea	--	-
		Missing data	-	-

Table 6: Chi Square showing Cross -Tab of Gender and NEEDs variables

S/N	INDEPENDENT VARIABLE	DEPENDENT VARIABLE (User Defined NEEDS on how NOUN Practical Teaching should be structured)	Asymp. Sig	Chi Square
1	Faculty of Study	Virtual Lab	0.608	1.830
		Physical Lab	0.419	2.825
		Teach with Presentation applications	0.742	1.247
		Free/Low cost internet	0.738	1.261
		Higher Practical grading	0.893	0.616
		Collaboration with other Universities	0.891	0.623
		Employ Qualified resource persons	0.164	5.109
		Study Groups	0.994	0.084
		Curriculum Development	0.985	0.153
		Teacher training		

		Record and burn to CD	0.818	0.930
		Longer practical sessions	0.992	0.096
		Make it Cost Effective	0.893	0.616
		Provide Strong internet coverage	0.002	14.331
		Practical should be on weekends	0.985	0.153
		Students should be notified of fixed practical sessions	0.985	0.153
		No idea	--	-

4.2 Discussion

Only the age of participants and the 16 factors of participant ideas on how practical labs should be taught are associated in the Chi square test of age and variables given by the participants. The statistical significance level of each variable in relation to its correlation with age is shown in the P-value column. The highest permissible statistical significance level is 0.05. Column with P-values (designated Asymp. For the variables to be declared statistically significant, Sig must be less than 0.05. To test the hypothesis, three demographic variables (age, gender, and field of study) were tested using the Chi Square test, with all dependent variables given by participants.

With a p-value of 0.006, the study revealed a statistically significant relationship between age and Virtual learning alone. A test of the relationship between participant gender and choice factors found no correlation with any of the variables mentioned. When Faculty of Study was compared to a student-suggested choice variable, statistical significance was found between Faculty of Study and need for excellent internet access.

H1: The current NOUN practical teaching technique is adequate for the development of competence and knowledge.

The connection between the current NOUN teaching technique, which is reported on the frequency table as Physical/Face-to-face, and other independent variables is explored using the Chi square test to test this hypothesis at a 95% confidence interval:

1. Independence test between physical lab and participant age: Age * Physical Lab has a p-value of 0.56 and a Chi Square value of 2.061 (p-value >0.05, indicating that the variable is not statistically significant and that there is no correlation).
2. The independence test of the connection between participant gender and * Physical lab yields a p-value of 0.206 and a Chi square value of 1.602 (p-value > 0.05, indicating no correlation).
3. Independent test of association between Faculty of study and Physical Lab: Faculty of study * Physical Lab yields a p-value of 0.419 and a Chi square of 2.825 (P-value >0.05, indicating that there is no statistical significance between the investigated variables).

The findings revealed that the current NOUN Practical teaching technique is insufficient since it has no relationship with any of the independent variables. As a result, the alternative hypothesis is rejected and the null hypothesis is accepted.

H0: The current NOUN practical teaching technique is insufficient for the development of competence and knowledge.

The test results, which show statistical significance between Age * Virtual Lab (p-value 0.006 and Chi square value of 12.500) and Faculty of study * Stronger Internet coverage (p-value 0.002 and Chi square value of 14.331) (tables 2 and 4) indicate that these variables are not independent but have a statistical relationship with the independent variables that make up demographic data.

Accepting the null (H0) hypothesis suggests that although physical labs are a popular option among participants, there are additional factors that would improve knowledge and skill development if included in the Practical laboratory. Virtual learning and better internet access were shown to be contributing factors in tests of all variables reported by the students.

5. Conclusion

This research used an open-ended questionnaire to gather student opinions on how to keep, enhance, or completely replace their current practical laboratory instruction. The target group comprises of NOUN graduates and students from diverse faculties, and their recommendations provided insight into the heterogeneity of a system like a learning institution. The practical learning options available to students are determined by their fields and the practical information to be provided. Students in the Chemistry department preferred physical laboratories, claiming that virtual practical learning makes it difficult to understand reagent reactions, whereas students in Computer Science, Architecture, and Engineering believe simulation and use of virtual environments are the fabrics of modern practical learning in their fields.

Many additional participants highlighted concerns about the distance between physical learning facilities and where most students work and study. Other recommendations include: early notice for courses, lengthier practical sessions, scheduling practical sessions on weekends, and the flexibility of learning methods via virtual learning so that distance is not a barrier.

NOUN, which now operates physical labs in zonal centres, should design and construct a virtual practical learning system that simulates real-life practical sessions, according to the researchers. Improved internet access, along with a hybrid of both physical and virtual practical learning, would address the NEEDS of NOUN students as identified in the NEEDs assessment survey. This is in line with Olebara's results [36], which suggest combining digital and traditional learning to accomplish in-depth information delivery.

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