

EVALUATION OF THE IMPACT OF E-LABORATORY ON ENGINEERING RESEARCH AND DEVELOPMENT IN NIGERIA: EMPHASIS ON UNIVERSITIES IN DELTA STATE

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ABSTRACT: *The study evaluated the impact of electronic laboratory to engineering research and development in Universities in Delta State. Three research questions and three corresponding hypotheses guided the study. Design of the study was descriptive survey. Population of the study comprised 12, 482 (8,338 academic and 4,144 administrative) while the sample for the study consisted of 747 (382 academic and 365 administrative) staff who were sampled for the study using random sampling technique. Instrument used for collecting data for the study was an 18 item questionnaire titled. The instrument was validated by three experts; one each from the Departments of Mechanical Engineering, Measurement and Evaluation, and Educational Management who assisted in determining the face and content validities of the questionnaire. The reliability of the questionnaire was determined using Cronbach Alpha with an index of 0.88. The research questions were answered using mean and standard deviation while the hypotheses were tested using z-test at 0.05 level of significance. The study revealed that online simulation laboratory, three-dimensional laboratory and computerized science laboratory all impact on engineering research and development. There was no significant difference in the opinion of academic staff and administrative staff on the impact of online simulation laboratory and three-dimensional laboratory but a significant difference existed on the impact of computerized science laboratory. Based on these findings, it was recommended that more technological facilities should be provided for the conduct of engineering research activities and the staff who carry put this research should be trained on modern technological research skills from time to time.*

KEYWORDS: E-laboratory, engineering, research, development, Delta State

INTRODUCTION

The University is often regarded as the knowledge hub of any society and this is attributed to the fact that it is from the University that refined knowledge for societal growth and development is

being produced. However, this advancement in knowledge will be impossible without adequate research activities (Elijah *et al.*, 2019; Ohia & Elijah, 2020). This is because research and development activities occupy a prime place in the growth and development of any nation. It is through research and development activities that the quality of human and material resources of any nation are being developed (Amini-Philips & Elijah, 2019). This has earned the University its prime function of research and development apart from other functions such as teaching and community service.

One of the known platforms for carrying out research and development in the University is through laboratory activities. The laboratory serves as a breeding ground for investigating and developing useful knowledge needed for solving environmental problems. The usefulness of the laboratory has given birth to the development of electronic laboratories which makes it easy for research activities to be carried out within a reasonable time frame and available resource.

Electronic laboratory also known as e-laboratory refers to a virtual laboratory where technological and computer related devices are used for carrying out research and experimental functions which would have been carried out in a field laboratory. Wheeling Jesuit University (2019) defined an e-lab vis-à-vis e-laboratory as a virtual and interactive live video expression of events. An electronic laboratory makes it easy for an informative experiment to be carried out in any area of science and technology.

One of the forms of electronic laboratory used to carry out experiments during engineering research activities is the online simulation laboratory. University of Buffalo (2019) explained that online simulation technology has a great impact on overall academic activities because it can be used in any area of academic research. Online simulation laboratories are important in the area of engineering since they provide ease of access to various engineering concepts which are required for solving problems in the field of engineering. Online simulation laboratory plays a significant role in the area of engineering drawing and other graphical areas as they make access to relevant information during such research easy and comprehensive. This form of laboratory deals with the use of the internet to proffer solution to problems that would have been carried out in a field laboratory.

The three dimensional laboratory is another aspect of electronic laboratory that is useful in the area of engineering research and development. The three dimensional laboratory plays a significant role in the analysis of objects from different perspectives (Edwards, 2014). Engineering is a field where graphics and development of models are common in practice. The three dimensional laboratory therefore assists an engineering to see engineering problems from different views and also assist in making the right choice in the midst of varying alternatives. This laboratory therefore assists an engineer during research activities to understanding engineering problems from different angles so as to be able to develop the right solution.

The field of science and engineering is going through series of metamorphosis over the last decades and as such the need for computerized science laboratory cannot be over emphasized (Hofstein & Lunetta, 2004; Elijah, 2019) in the field of science and engineering. Computerized science laboratory are relevant during research and development as the form part of the future contributions

of the field of engineering to societal growth and development. The field of engineering among other things therefore relies heavily on the use of electronic laboratories for its research activities in the process of proffering solutions to the problems of the society.

The aim of the study was to evaluate the impact of e-laboratory on engineering research and development in Universities in Delta State. The specific objectives are to:

1. examine the impact of online simulation laboratory on engineering research and development in Universities in Delta State
2. ascertain the impact of three dimensional laboratory on engineering research and development in Universities in Delta State
3. determine the impact of computerized science laboratory on engineering research and development in Universities in Delta State

Research Questions

The following research question guided the study:

1. What is the impact of online simulation laboratory on engineering research and development in Universities in Delta State?
2. What is the impact of three dimensional laboratory on engineering research and development in Universities in Delta State?
3. What is the impact of computerized science laboratory on engineering research and development in Universities in Delta State?

Hypothesis

The following hypotheses were tested at 0.05 level of significance:

1. There is no significant difference between the mean scores of academic and administrative staff on the impact of online simulation laboratory on engineering research and development in Universities in Delta State
2. There is no significant difference between the mean scores of academic and administrative staff on the impact of three dimensional laboratory on engineering research and development in Universities in Delta State
3. There is no significant difference between the mean scores of academic and administrative staff on the impact of computerized science laboratory on engineering research and development in Universities in Delta State

METHODOLOGY

The design adopted for the study was descriptive survey. The population of the study was 12, 482 (8, 338 academic and 4,144 administrative) out of which 747 (382 academic and 365 administrative) staff were sampled for the study using random sampling technique. The instrument used for data collection was an 18 item questionnaire titled “Impact of E-laboratory on Engineering Research Questionnaire” (IEERQ) which were responded to on a four point modified Likert scale

of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) with weights of 4, 3, 2 and 1 respectively. The instrument was validated by three experts; one each from the Departments of Mechanical Engineering, Measurement and Evaluation, and Educational Management who assisted in determining the face and content validities of the questionnaire. The reliability of the questionnaire was determined using Cronbach Alpha with a reliability co-efficient of 0.88. The questionnaire was administered by the researcher as well as two trained Research Assistants. The research questions were answered using mean and standard deviation while the hypotheses were tested using z-test at 0.05 level of significance.

RESULTS

Answer to Research Questions

Research Question One: What is the impact of online simulation laboratory on engineering research and development in Universities in Delta State?

Table 1: Mean and standard deviation scores on the impact of online simulation laboratory on engineering research and development in Universities in Delta State

S/No	Items	Academic Staff n=382			Administrative Staff n=365		
		Mean	SD	Remark	Mean	SD	Remark
1	Research findings can be used to reach a larger audience	2.66	0.63	Agreed	2.74	0.78	Agreed
2	Collaborative ideas can be developed among different researchers	2.93	0.70	Agreed	2.74	0.78	Agreed
3	Enhances access to laboratory equipment	3.00	0.40	Agreed	3.60	0.61	Agreed
4	Research errors are greatly reduced	2.92	0.72	Agreed	2.56	1.03	Agreed
5	Cost of research is reduced when using online simulation	2.92	0.72	Agreed	2.63	0.88	Agreed
6	Research findings can be easily assessed using online simulation laboratory	2.96	0.82	Agreed	2.90	0.45	Agreed
	Average	2.89	0.67	Agreed	2.86	0.76	Agreed

In Table 1, it was revealed that the academic staff sampled for the study responded to items 1, 2, 3, 4, 5 and 6 with mean scores of 2.66, 2.93, 3.00, 2.92, 2.92 and 2.96 while the administrative

staff responded to the same set of items with mean scores of 2.74, 2.74, 3.60, 2.56, 2.63 and 2.90. All the items were agreed since the mean scores were above the criterion mean score of 2.50 used for decision making. In summary, with an average mean score of 2.89 and 2.86, the academic staff and administrative staff both agreed respectively on the impact of online simulation laboratory on engineering research and development in Universities in Delta State.

Research Question Two: What is the impact of three dimensional laboratory on engineering research and development in Universities in Delta State?

Table 2: Mean and standard deviation scores on the impact of three dimensional laboratory on engineering research and development in Universities in Delta State

S/No	Items	Academic Staff n=382			Administrative Staff n=365		
		Mean	SD	Remark	Mean	SD	Remark
7	Research findings can be easily harmonized	2.51	0.95	Agreed	2.78	0.96	Agreed
8	Accurate research findings are developed	2.64	0.91	Agreed	2.03	0.97	Disagreed
9	Outcome of research are easy to understand	2.56	0.89	Agreed	2.69	0.85	Agreed
10	New research ideas are easily developed in a three dimensional laboratory	2.62	0.66	Agreed	3.42	0.76	Agreed
11	Resource wastage is reduced in a three dimensional laboratory	2.98	0.74	Agreed	2.90	1.01	Agreed
12	Research flaws are minimized when using three dimensional laboratory	3.10	0.72	Agreed	2.20	1.06	Disagreed
	Average	2.74	0.81	Agreed	2.67	0.94	Agreed

Table 2 revealed that the academic staff responded to items 7, 8, 9, 10, 11 and 12 with mean scores of 2.51, 2.64, 2.56, 2.62, 2.98 and 3.10 while the responses of the administrative staff to the same set of items produced mean scores of 2.78, 2.03, 2.69, 3.42, 2.90 and 2.20. All items above the criterion mean score of 2.50 were agreed while those below the criterion mean were disagreed. In summary, with an average mean of 2.74 and 2.67, the academic staff sampled for the study agreed a little more than the administrative staff on the impact of three dimensional laboratory on engineering research and development in Universities in Delta State respectively. This decision

was based on the fact that the average mean scores were above the criterion mean score of 2.50 used for making decision.

Research Question Three: What is the impact of computerized science laboratory on engineering research and development in Universities in Delta State?

Table 3: Mean and standard deviation scores on the impact of computerized science laboratory on engineering research and development in Universities in Delta State

S/No	Items	Academic Staff n=382			Administrative Staff n=365		
		Mean	SD	Remark	Mean	SD	Remark
13	Team work among researchers can be easily executed	2.50	0.78	Agreed	2.85	0.45	Agreed
14	Research findings can be easily tested using the computer laboratory	2.78	0.69	Agreed	2.02	1.01	Disagreed
15	Safe research activities can be conducted with ease	2.21	1.03	Disagreed	2.93	0.40	Agreed
16	Research findings are easily documented	2.91	0.45	Agreed	2.55	0.98	Agreed
17	Rigorous research activities can be easily conducted	2.94	0.63	Agreed	2.95	0.58	Agreed
18	Professionalism is developed when using a computerized science laboratory	2.86	0.75	Agreed	3.57	0.62	Agreed
Average		2.70	0.72	Agreed	2.81	0.67	Agreed

Table 3 indicated that the mean scores of the academic staff and the administrative staff to items 13, 14, 15, 16, 17 and 18 were 2.50, 2.78, 2.21, 2.91, 2.94 and 2.86 as well as 2.85, 2.02, 2.93, 2.55, 2.95 and 3.57. Items with mean scores above the criterion mean score of 2.50 were agreed while those below the criterion mean were disagreed. Summarily, with an average mean score of 2.70 and 2.81, the academic staff sampled for the study as well as the administrative staff both agreed on the impact of computerized science laboratory on engineering research and development in Universities in Delta State.

Test of Hypotheses

Hypothesis One: There is no significant difference between the mean scores of academic and administrative staff on the impact of online simulation laboratory on engineering research and development in Universities in Delta State

Table 4: z-test analysis of no significant difference between the mean scores of academic and administrative staff on the impact of online simulation laboratory on engineering research and development in Universities in Delta State

Variable	n	Mean	SD	df	z-cal.	z-crit.	Level of Significance	Decision
Academic Staff	382	2.89	0.67	745	0.60	1.96	0.05	Ho was not rejected
Administrative Staff	365	2.86	0.76					

In Table 4, since the value of z-cal. of 0.60 was less than the value of z-crit. of .96, the null hypothesis was not rejected implying that there was no significant difference between the mean scores of academic and administrative staff on the impact of online simulation laboratory on engineering research and development in Universities in Delta State

Hypothesis Two: There is no significant difference between the mean scores of academic and administrative staff on the impact of three dimensional laboratory on engineering research and development in Universities in Delta State

Table 5: z-test analysis of no significant difference between the mean scores of academic and administrative staff on the impact of three dimensional laboratory on engineering research and development in Universities in Delta State

Variable	n	Mean	SD	df	z-cal.	z-crit.	Level of Significance	Decision
Academic Staff	382	2.74	0.81	745	1.17	1.96	0.05	Ho was not rejected
Administrative Staff	365	2.67	0.94					

Table 5 showed that the value of z-cal. of 1.17 was below the value of z-crit. of 1.96. Therefore, the null hypothesis was not rejected and as such it was agreed that there was no significant difference between the mean scores of academic and administrative staff on the impact of three dimensional laboratory on engineering research and development in Universities in Delta State

Hypothesis Three: There is no significant difference between the mean scores of academic and administrative staff on the impact of computerized science laboratory on engineering research and development in Universities in Delta State

Table 6: z-test analysis of no significant difference between the mean scores of academic and administrative staff on the impact of computerized science laboratory on engineering research and development in Universities in Delta State

Variable	n	Mean	SD	df	z-cal.	z-crit.	Level of Significance	Decision
Academic Staff	382	2.70	0.72	745	2.20	1.96	0.05	Ho was rejected
Administrative Staff	365	2.81	0.67					

In Table 6, since the value of z-cal. of 2.20 was above the value of z-crit. of 1.96, it was concluded that there was a significant difference between the mean scores of academic and administrative staff on the impact of computerized science laboratory on engineering research and development in Universities in Delta State.

DISCUSSION OF FINDINGS

Impact of online simulation laboratory on engineering research and development in Universities in Delta State

Online simulation laboratory plays an important role in the area of engineering research and development. This is because this type of laboratory provides access to variety of information that is required for engineering research and development. This may explain why the respondents of the study revealed that one of the impact of this type of electronic laboratory is that it provides research findings that can be adopted in different geographical locations. Astra, Nasbey and Nugraha (2015) explained further on the score of the online simulation laboratory and the impact it makes when they asserted that a simulation lab has been made subsequently validated by concept and media experts and that further empirical testing by teachers and students revealed that the feasibility of the media on all indicators are 83.13% from media experts, 87.5% from concept experts, 83.13% from empirical test of teachers, and 78.51% from student test. It was concluded from the study that the android application in the form of a simulation lab can be used as a learning media for senior high school students. The expansion of the mobile technological industry has therefore widen the score of online simulation laboratory for research purposes both among students and teachers in engineering related fields and the outcome of this research has a positive impact on almost the entire human race.

The ease of accessing technological devices has gone to a great extent to expand the area of online simulation laboratory as well as the impact it can make for the human society such as enhancing collaborative research and providing the opportunity for research findings to be properly evaluated across different locations. Falode and Gambari (2017) reported in the findings of their study that online simulation laboratory was accessible with a mean of 2.98 but not flexible to use and was expensive to develop. This finding suggests the need for more emphasis to be laid among stakeholders on how online simulation laboratories can be made as flexible as possible and improving on their availability for individual, institutional as well as societal benefit especially in the area of engineering research and development activities.

Impact of three dimensional laboratory on engineering research and development in Universities in Delta State

The three dimensional laboratory plays a significant role in the area of engineering research where lots of designs and construction activities are often carried out. The three dimensional laboratory is therefore relevant in the area of engineering research and development as it provides different alternatives to the design and construction activities often carried out by an engineer. Sinhuber, Vaart, Ni, Puckett, Kelley and Ouellet (2019) emphasized the impact of the three dimensional laboratory to the field of engineering research and development when they opined that the three dimensional concept can be used to study a phenomenon as a whole. This implies that the three dimensional laboratory assists greatly in the study of research concepts as a whole instead of in bits in the area of engineering research and development. This provides a holistic approach to research activities in any field of engineering.

The respondents used for the study also pointed out that three dimensional laboratory helps to reduce wastage in the area of engineering research and also assists in minimizing error during engineering research. This may not be unconnected with the fact that the three dimensional laboratory assists a researcher in the field of engineering to understand ongoing research from a broader perspective thus limiting research errors and wastages. Supporting this perspective, Mahmoud and Bennett (2015) revealed that the three dimensional laboratory are used in mechanical engineering and architecture. It is used to achieve any research in engineering and produces quality research output than other laboratories. Engineering researchers therefore stands a chance of achieving efficiency and effectiveness in their research activities when such research is carried out in a three dimensional laboratory.

Impact of computerized science laboratory on engineering research and development in Universities in Delta State

Computerized science laboratories also have great significance in the field of engineering research. It is almost impossible to carry out any modern engineering research activity without the use of the computer. The computer has therefore become a useful laboratory for carrying out engineering research and development activities. The respondents for the study agreed with this position when they asserted that the computerized science laboratories helps to ensure the safety of research activities and also contributes to developing professionalism in the field of engineering research and development. This may explain why Srisawasdi (2012) pointed out in the findings of his study that groups do not differ in their perception on the support of computerized science laboratory. This was because it was revealed that there was ease of using these laboratories for self-learning. The computerized science laboratory therefore goes a long way in making an engineering researcher a professional in the area of research and development.

However, the academic staff and administrative staff sampled for the study were at contrast on whether the computerized laboratory makes it easy for research findings to be evaluated. Supporting this position, Kwok (2015) also reported that the computerized laboratory proved to be useful but needed more improvement. It therefore means that the computerized science laboratory will be more useful in the area of engineering research if more engineering research and

development software and hardware are developed to make this laboratory more efficient for use in research and development activities for engineers.

CONCLUSION

The study concluded as follows:

E-laboratory in all its form; online simulation laboratory, three dimensional laboratory and computerized science laboratory have impact on engineering research and development in Universities in Delta State. Therefore, investment in e-laboratory will go a long way in enhancing engineering research and development within and outside the University.

Recommendations

The following recommendations were made based on the findings of the study:

1. There is need for the University to invest in modern technology such as internet facilities and other technological devices that will make it easy for the University to engage in online simulation activities. This will help to promote the globalization of research findings from these Universities.
2. Teachers as well as students need to be trained and re-trained in the area of three dimensional laboratory development. This will enable these students and staff to acquire the needed skills and knowledge for conducting research activities using the three dimensional laboratory for societal growth and development.
3. It is important for staff of the University to also develop modern computer software that will make it easy for other staff of the University to carry out research and development activities in the University for National Growth and development.

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