IOSR Journal of Research & Method in Education (IOSR-JRME)
e-ISSN: 2320–7388, p- ISSN: 2320-737x Volume 14, Issue 1 Ser. 3 (Jan. – Feb. 2024), 08-13
www.iosrjournals.org

Assessment Of Virtual Reality As A New Direction For Improveing The Teaching And Learning Of Electrical/Electronics Technology Education In Nigerian Universities

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Abstract
Nigerian university education system has been criticized in many quotas especially in trade areas such as electrical/electronic technology education. Graduates are not employable and they cannot practice because they lacked required skills because their trainings were carried out in conventional, obsolete and inadequate facilities. Nigeria requires a new direction to improve the quality of education. Historically, most technologies designed to aid learning have been aimed at enabling access to information — facts and observations about systems. Before computers, there was a powerful conventional tool that helped us retain facts: books. Drastic global changes have seriously challenged such conventional approaches to education and tilted towards information and communication technologies Therefore, this nonequivalent, two group, quasi-experimental study compared efficiency of desktop virtual reality with a conventional classroom learning practice for the teaching and learning of electrical/electronic technology education. A total of 142 students participated in the study. Skill achievement test and job interest survey were used for data collection. One way analysis of covariance was used to analyse the collected data at a 0.05 level of significance. Results indicated a higher skill achievement by the virtual reality group. Also, the virtual reality group indicated a higher interest in continuing in the line of their trade and self-employment after graduation. It was recommended that virtual reality laboratories be established in Nigerian universities to improve teaching and learning.

Key Words*: virtual reality, electrical/electronic technology, teaching and learning, university.*

Date of Submission: 05-02-2024 Date of Acceptance: 15-02-2024

I. Introduction

A sound university education is the bedrock for a sustainable development of any nation. Effective university education produces human capital for socioeconomic development. A considerable progress can be accomplished in a nation by its people through successful implementation of university educational process. Such a right educational bearing will yield large social returns, in health, wealth and social well-being. Sound university educational system does not evolve by accident. It is painstakingly achieved when strong, visionary leaders implement a well-developed strategy with sincerity and discipline (Gbadegesin, 2017).

In Nigeria, the major indicators of quality university education are at their lowest levels, leading to the production of poor quality graduates, who are been advised by the government to go to the farm in the absence of job opportunities and irrespective of what they studied. Some of those who do not want to go to farm become miscreants engaging in prostitution, human trafficking, drug trafficking, banditry, robbery, kidnapping, cybercrime and other social ills (Alemika, 2004; Nigeria Stability and Reconciliation Programme [NSRP], 2014). This condition arose because the learning environment in Nigerian universities is ineffective in enhancing academic achievement and coping with present modern global work situations.

Nigerian university education has been highly criticized, especially in industrial trade areas such as electrical/electronic technology education. Graduates are not employable and cannot practice because they are deficient in required skills. They lack the applied technical skills necessary for solving problems and enhancing business productivity (Akinyemi, et al 2012). Because they lack the basic skills and knowledge required by industry (Ibanga, 2015), they are neither able to take advantage of available employment opportunities nor

create employment. Therefore, some courses in Nigerian universities are oversubscribed, while so many others receive only applicants who were rejected in their choice courses.

Some researchers blamed the situation on teaching methods (Zuofa & Olori, 2015; Ogunyinka, et al, 2015). But Oranu (1990) argued that lack of physical facilities was the major problem of tertiary institutions in Nigeria. Okoro (1998) lamented that ineffective teaching may be caused by lack of suitable tools, equipment, and materials due to inadequate funding. The author stressed that facilities such as buildings, equipment, tools, and school materials available for training are inadequate for effective use in Nigerian schools. Other researchers agreed that the problem was inadequacy of learning facilities, use of obsolete materials (Bello, 2013), and lack of maintenance (Efuwape & Aremu, 2013). The Nigerian government is aware that only limited equipment and facilities exist for school teachers at different levels, including universities (Federal Republic of Nigeria, 2014, July 7).

This situation of learning facility deficiency is more pronounced in technology related areas such as electrical/electronic technology education. Studies revealed that facilities for the learning of electrical/electronic technology in Nigerian universities were inadequate in terms of numbers and functionality. The few available facilities were either broken down or lacked adequate maintenance. This might have given rise to unprecedented levels of university graduate unemployment and ravaging poverty as witnessed by graduates of electrical/electronic technology in Nigeria today (Akinyemi et al., 2012; National Bureau of Statistics, 2016). Eme (2014) lamented that in Nigeria there was need for a total overhauling of the educational system and that in many fields graduation from the university only leads to rising unemployment, poverty, and misery. Prosser and Quigley (1949) emphasised that there is a minimum level of facilities below which effective vocational education such as electrical/electronic technology cannot be given, and if the course does not permit this minimum per capita cost, vocational education should not be attempted.

Inadequate provision of teaching and learning facilities could be due to low level of funding of tertiary institutions in Nigeria. It was found that Nigeria remains a major culprit in complying with the United Nations Educational, Scientific and Cultural Organization (UNESCO) recommendations that at least 26% of the national budget must be committed to education (Umunadi, 2010). The 2019 federal government budget of N8.83trillion allocated only N620.5bn (about 7.05 per cent) to education, a marginal raise over 7.03% budgeted for the sector in 2018 and lower than the 7.4% the same government allocated to education in the 2017 budget (Federal Government of Nigeria, 2019). These were far below the UNESCO recommendation of 26% and cannot provide needed facilities for effective education. Consequently, the learning environment in Nigerian universities was made ineffective to produce quality electrical/electronic technology education graduates.

Electrical/electronic technology is one of the technical and vocational education courses that focus on employment generation and poverty reduction. Therefore, to reduce unemployment and poverty in Nigeria, the study of electrical/electronic technology has to be made effective. This can be achieved by training the students in a learning situation that resembles the environment where they are expected to work. This requires well equipped laboratories and classrooms. The weak economy and flagrant corruption experienced in present Nigeria has made it extremely difficult to establish and maintain an effective learning environment. May (2007) observed that technical and vocational education in general, and indeed electrical/electronic technology, were still neglected in adequate provision of, personnel, modern facilities, and staff motivation. Therefore in the present situation, students try to learn in a very quiescent manner (Oluwale et al., 2013; Ayonmike, et al, 2015). This consequently robbed Nigeria of the economic development that would have been contributed by graduates of electrical/ electronics technology and thereby exacerbated unemployment in the nation.

Therefore, a modern method of increasing learning effectiveness of electrical/electronic technology is imperative. One such modern method could be virtual reality. Virtual reality has been effectively used to augment teaching and learning facilities in several fields of education (Lee, et al, 2009; Nelson, 2014; Friena & Ott, 2015). Virtual reality has been judged an appropriate and powerful environment for teaching and learning in school situations, especially for technology related areas which involve the study of naturally observable facts, theoretical ideas, and tangible interconnection of parts (Ausburn & Ausburn, 2008) such as electrical/electronic technology.

There are two major types of virtual reality for teaching and learning. The first is the immersive system. Immersive virtual reality environments are presented on multiple, room-size screens or through a stereoscopic, head-mounted display unit (Strickland, 2013). Dedicated tools such as sensors on the head-mounted device and data gloves track the participant's movements during exploration and provide feedback that is used to modify the display to facilitate instantaneous flexibility. This environment may take the form of a series of large screens or a complete cave automatic virtual reality system (Virtual Reality Society, 2016). The need for expensive peripheral devices and high end computer systems has somewhat restricted its use in schools or colleges (Lee et al., 2009). Moreover, there are unresolved questions relating to health and safety issues that arise in the use of immersive virtual reality systems (Nelson, 2014; Friena & Ott, 2015). The second approach involves a conventional desktop setup. This form is called desktop, non-immersive, or fish tank virtual reality.

In desktop virtual reality, the interactive three-dimensional (3-D) computer generated program in a multimedia environment is presented on a conventional personal computer and is usually explored using keyboard, mouse, wand, joystick, or touch screen (Strangman & Hall, 2003; Friena & Ott, 2015). Desktop virtual reality has been widely used for classroom learning because of its viability and cost efficiency (Strangman & Hall, 2003).

Desktop virtual reality is more affordable than its immersive counterpart. Although an opinion exists that desktop virtual reality is less immersive, Dalgarno et al. (2002) argued that the sense of presence or immersion in a virtual environment is induced by the representational fidelity and the high degree of interaction and control of the user, rather than a simple unique attribute of the environment. Moreover, there is no overwhelmingly conclusive evidence that immersive systems are more effective in educational applications than their non-immersive counterparts (Youngblut, 1998; Strickland, 2013). Rather, the non-immersive technology is much more mature and is widely used in many different application areas compared to immersive technology which is cumbersome, expensive, and occupies a great deal of space (Youngblut, 1998). Woodford (2015) emphasized that desktop virtual reality is collaborative, unlike its immersive counterparts. Collaboration is a vital aspect of effective teaching and learning in technology-related fields such as electrical/electronic technology. Moreover, a rapid and drastic fall in prices and a huge leap and improvement in the processing power of personal computers has enhanced the use of desktop virtual reality in schools and colleges (Lee et al., 2009). Researchers have emphasized the positive learning outcomes of desktop virtual reality technology to support learning (Lee et al., 2009; Ogbuanya & Onele, 2018).

Although virtual reality is a proven effective educational tool, it might not be effective for all types of learning (Lee et al., 2009). It would then be precipitate to make wide recommendations regarding the use of virtual reality as a teaching and learning enhancement tool (Strangman & Hall, 2003). Therefore, it should not be used indiscriminately in any educational program (Sanchez, et al, 2000) without an empirical verification. Therefore, the efficiency of virtual reality for teaching and learning in any field should be determined by an empirical study. Very few studies have successfully compared the efficiency of virtual reality and non virtual reality for teaching and learning (Lee et al., 2009; Ogbuanya & Onele, 2018). The purpose of this study was to compare the efficiency of a desktop virtual reality learning environment with a conventional classroom for teaching and learning of electrical/electronic technology education and determine how a desktop virtual reality-based learning environment can affect the academic achievement of electrical/electronic students in Nigerian universities.

II. Materials and Methods

A two-group, nonequivalent pretest-posttest quasi-experimental design was employed for this study. The study was carried out on 300-level electrical and electronics technology students. Three hundred-level students were chosen because they fell within the targeted population and had an idea of electronics circuit construction. The ages of the students ranged from 18 to 24 years. This age range has been found to be predisposed to computer usage (Statista, 2018), especially among those who were undergraduates (DeBell & Chapman, 2004). Four universities (two from the southern Nigeria and two from the northern Nigeria) were selected through simple random sampling of 34 government owned universities in Nigeria accredited for electrical/electronic technology education. For each selected university, one intact class was used. The selected classes were assigned into experimental and comparison (control) groups by tossing of coin. One control group was used from the south and the other from the north. A total of 142 students participated in this experiment: Seventy-four students were in the virtual reality group, while 68 students were in the non virtual reality group. The sample was 70.25% and 29.75% male and female, respectively. Both pretest and posttest were similar in content but the order of the questions was different to avoid the set response effect.

Students' academic achievement was measured by their mean score in a researcher-made achievement test. The test included measurements and calculations in circuit theorem. The test was authenticated for content validity, difficulty index, item discrimination index, and internal consistency measure. It yielded an alpha coefficient of 0.846.

A desktop virtual reality program, Electric Vlab, with 120 electronics components and developed by Quality Assurance LLC was used to provide the virtual learning environment to students. Two weeks before the treatment, respondents from both experimental and control groups were given a pretest. During the treatment, the experimental groups were taught using the virtual reality software program (Electric Vlab), whereas the control groups underwent a conventional classroom learning method. The teaching and administration of tests were carried out by the researcher and three paid assistants who were trained instructors of electrical/electronics technology. They were also trained on how to use virtual reality for teaching and learning. Analysis of covariance (ANCOVA) was used to analyze the data. The choice of ANCOVA was made because of its ability to take care of extraneous variables that could arise from pre-interventions since there was no randomization (Tabachnick & Fidell, 2013). ANCOVA is used in experimental studies when researchers want to remove the effects of some antecedent variable.

III. Results and Discussion/Findings

Results of this study are presented below

Table 1
Mean and Standard Deviation of Academic Achievement Scores of Electronic Technology Education Students who were Taught in Virtual Reality and those Taught in Conventional Classroom in Nigerian Universities

		Descriptive Statistics				
Studied Groups	**Group**	**Pretest Mean**	**Post Test Mean**	**Std. Deviation**	**Mean Interest**	**N**
Conventional classroom	1	**15.21**	**51.75**	9.75	2.17	74
Virtual Reality class	2	**14.98**	**78.23**	3.93	4.39	68
	Total	**15.10**	**64.99**	6.34	3.28	142

Table 1 showed that students in conventional classroom had a mean achievement score of 51.75 % and standard deviation of 9.75, while students in virtual reality class had a mean achievement score of 78.23% and standard deviation of 3.93. This showed that the virtual reality class achieved slightly higher than the conventional class. Conventional class had a higher standard deviation, which suggested that their score was wider apart than the virtual reality class. Also, virtual reality class indicated higher interest (4.23) than the conventional class (2.17).

Table 2
Summary of Analysis of Covariance (ANCOVA) Test of Significant Difference in the Mean Academic Achievement Scores of Electronic Technology Education Students Taught in Virtual Reality and those Taught in Conventional classroom in Nigeria Universities.
Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	410.474	3	136.825	1.598	.198	.066
Intercept	279351.158	1	279351.158	3261.586	.000	.979
Groups	**343.929**	**2**	**171.964**	**3.64**	**.142**	**.155**
Error	**5909.773**	**137**	**85.649**			
Total	379443.000	142				

The result in Table 2 indicated that calculated F-value (3.64) was higher than the Table F value of 3.13 at 0.05 level of significance and degree of freedom 2 and 69. This indicated that there was a significant difference in the mean academic achievement of students in the virtual reality class and those in the conventional classroom. Therefore, the null hypothesis of no significant difference between the mean academic achievement score of students in the virtual reality group and the conventional classroom was rejected. The result also indicated a partial eta squared of 0.16. Anglim (2011), who asserted that 0.01=small effect, 0.06=medium effect, and 0.14=large effect. Lenhard and Lenhard (2016) concluded that <0= adverse effect, 0.003= no effect, 0.039=small effect, 0.110=intermediate effect, and 0.140 and above=large effect. Other researchers confirmed that effect size of 0.3 and above falls within the desired zone (Wiliam, Lee, Harrison, & Black, 2004). Hattie (1999) stated that effect sizes of 0.40 and above are attributable to specific interventions or methods being researched and that such changes are beyond natural maturation or chance. Therefore, with an effect size of 0.62, virtual reality positively affected the academic achievement of students in electrical/electronic technology.

Table 3
Summary of Post Hoc Test on Source of Significant Difference in the Mean Academic Achievement Score of Electronics Technology Education Students taught in Virtual Reality and conventional classroom.
Post Hoc Test of students' Academic Achievement Scores

	Group	N	Subset	
			1	2
Duncan	Conventional classroom	68	**51.75**	
	Virtual Reality Class	74		**78.23**
	Sig.		1.000	.908

Table 3 shows that there was no significant difference in the mean academic achievement score difference of conventional class and virtual reality class. This confirms that students in the virtual reality class achieved significantly better than the students in conventional class

Findings from this study supported the alternate hypothesis that a virtual reality-based learning environment positively affects the academic achievement of electronics technology students. The students achieved higher in the virtual reality-based learning environment than in the conventional setting. The higher achievement in the virtual reality group indicated that virtual reality was an educational tool that could enhance learning and make learning of electrical/electronic technology more interesting and stimulating. Higher students' interest in virtual reality may have also contributed to higher achievement. This result was consistent with the findings of Lee et al. (2009) and Moazami, et al (2014). It was argued that only those experiments that involve hands-on and minds-on activities and in which students could actively be involved in the learning process can be enhanced by computer assisted learning such as virtual reality (Chang & Barufaldi, 1999; Lee et al., 2009). However, some research findings showed no significant advantage of using virtual reality-based learning over conventional instruction on students' achievement, as in the study of Snyder et al (2011), and Chatfield (2014). This variance could result from the level of equipment in the areas where these studies were carried out. Some physical laboratories in developed countries are equipped with all needed facilities. In such cases, virtual reality may not be more effective than a conventional setting. Nigerian universities lacked some of the facilities for optimum laboratory practice.

IV. Conclusions and Recommendations

The results of this study have supported some previous findings that virtual reality could improve academic achievement, interest, and engagement. Moreover, these results have contributed to the limited findings on comparing virtual reality against other methods of teaching and learning. In this study, students in the virtual reality group did not only achieve higher results but also showed more positive attitudes while learning with virtual reality, resulting in higher engagement in their class activities.

However, some studies did not find virtual reality as an effective educational tool. Peter and William (1999) stated that whether to build accurate representations of reality, create consensual meanings in social activities, or personally coherent models of realities, experience is still paramount. Experience would be effective if facilities available for teaching and learning were enough to bring about the desired educational goal. This study was carried out in four Nigerian universities where their equipment were rated high for the study of electrical/electronic technology (Nigerian Universities Commission, 2016). However, these highly rated institutions lacked basic teaching facilities when compared to international standards. Therefore, an unconventional way of providing effective instruction within Nigerian universities, such as VR technology, should be considered. Although virtual reality should not be seen as a panacea that supports all kinds of educational situations, its ability as an effective instruction intervention for teaching courses that are abstract, difficult to teach and learn, and risk bound, like electrical/electronic technology, should not be underestimated. Furthermore, the present Nigerian undergraduates are a digital generation where computers have become part of everyday life. This could be exploited for better educational achievement in Nigeria.

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