Sub-Sahara African Academic Research Publications
June, 2021, Editions

JPAS
Journal of Pure and Applied Science
Vol..20, No.9, ISSN 2318-9315

STATISTICAL ANALYSIS OF EFFECT OF DIGITAL INSTRUCTIONAL MATERIAL ON ACHIEVEMENT OF ENGINEERING STUDENTS IN ELECTRICAL SCIENCE

ONWUBUMPE, BIBIANA NKIRUKA; & AKUNNA, OGOCHUKWU AGATHA
Department Of Statistics, Federal Polytechnic Oko, Nigeria

Abstract

The paper, which contained two research questions and two hypotheses, focused on statistical analysis of effect of digital instructional material on achievement of engineering students in electrical science. A sample size of 264 students was purposively drawn from a population made of all national diploma engineering students in the polytechnics in the south-east zone of Nigeria. A quasi-experiment was carried out by using digital instructional material and analogue instructional material in teaching an experimental group and control group respectively. The two groups (digital and analogue) were subjected to pre-test and post-test. The instrument for data collection was Students' Achievement Test on Electricity (SATE) which is a 50-item 4-option multiple choice objective test with reliability co-efficient of 0.89. Statistically, the research questions were answered using mean and standard deviation, while the hypotheses were tested at 0.05 level of significance using ANCOVA. Results obtained showed that engineering students taught electrical science with digital instructional material has higher mean achievement score than those taught with analogue instructional material. Hypothesis tested (F = 288.504, P = 0.000) revealed that there was a significant difference in the mean achievement scores of the two groups of students. Also, result from the hypothesis tested (F = 0.469, P = 0.494) showed that there was no significant difference in the mean achievement scores of male and female polytechnic engineering students, although the female students had a slightly higher mean achievement score than the male students. Conclusion from the statistical deduction is that digital

instructional material is more effective than analogue instructional material in enhancing polytechnic national diploma engineering students' achievement in electrical science.

Keywords: *statistical analysis, instructional material, electrical science, achievement, engineering students.*

Introduction

The study and practice of engineering, as an aspect of science and technology, requires statistical analysis, which in turn involves mathematics. According to Akunna and Onwubumpe (2019), mathematics is employed in science and technology for computation, design, analysis, and evaluation using data and information obtained from natural phenomenon and experimentation. Nwosu, Oguagbaka and Akunna (2015) asserted that among the wide applications of mathematics in science and technology is analysis and interpretation of raw data.

Among the courses that involve mathematics which national diploma engineering students of Nigerian polytechnics are taught is electrical science. Electrical science is mainly concerned with static electricity (charge at rest) and current electricity (charge in motion). Nwosu, Odigwe and Nwoye (2015) pointed out that current electricity is concerned with properties and effects of electrical charges in motion. Electrical science has brought a lot of technological advancement in this modern era as can be seen in existence of electrical power supply, electrical machines, telecommunication and computerization.

To achieve effective teaching and learning in electrical science, instructional materials are required. Okoro and Ali-Okoro, 2016) averred that instructional materials are resources which are information carriers designed to accomplish curriculum objectives in a teaching-learning situation. Instructional materials are materials or objects which a teacher utilizes to ensure that learning become more effective by motivating the learner and directing his/her attention properly (Nwoye & Nwosu, 2018). It can be stated that instructional materials are resources or devices which a teacher uses to create interest and motivation for

learners to understand the organized knowledge, skills and attitude being transmitted.

Provision of instructional material for the teaching and learning of electrical science demands formation of electric circuit. Electric circuit is assemblage of electrical components for the flow of electrical current (ie movement of charge). Electric circuit can consist of measuring instruments and non-measuring instruments. The measuring instruments can be analogue or digital in nature. Analogue instrument indicates its readings using pointer; while digital instrument displays its readings in numerical form.

Over the years, analogue electric circuit has been the instructional material which polytechnic national diploma engineering students have been taught electrical science. Unlike digital electric circuit which usually displays readings in fast and accurate manner, analogue electric circuit has the problem of one experiencing parallax error and not observing readings in an easy manner.

It is essential to carry out a statistical analysis on the effectiveness of digital instructional material (electric circuit) by checking its effect on the achievement of polytechnic national diploma engineering students. This is pertinent because some studies have shown that instructional material has a bearing with achievement (Mboto, Ndem & Stephen, 2011; Oladejo, Olosunde, Ojebisi & Isola, 2011; Onasanya & Omosewo, 2011). Egbo (2014) viewed academic achievement as the scholastic standing of a student at a given moment which states individual's intellectual abilities, which can be measured by grades obtained in a course or group of courses taken within a stipulated period. The statistical analysis will also involve checking if digital instructional material is gender friendly. There are some studies that showed that influence of gender can be checked on students' achievement (Achor, Taangahar & Musa, 2011; Okeke, 2011). Udosoro in Mbonu (2018) asserted that gender is a cultural construct that distinguishes the roles, behaviour, mental, and emotional characteristics between males and females developed by a society.

Statement of the Problem

In the polytechnics in the south-east zone of Nigeria, analogue measuring instruments are mostly used, as part of the instructional material, in the teaching of electrical science. Problem in the use of analogue electric circuit is existence of parallax error and observing of readings in uneasy manner. Digital electric

circuit usually does not have such problem because it displays readings in fast and accurate manner. The problem in the use of analogue instrument is an unfortunate situation for it can impair effective teaching and learning of electrical science. Thus, there is need for statistical analysis of the effect of digital instructional material on engineering students' achievement in electrical science.

Purpose of the Study

The general purpose of this study is statistical analysis of effect of digital instructional material on achievement of engineering students in electrical science. Specifically, this study was embarked upon to:

1. Find out the effect of digital instructional material and analogue instructional material on the mean achievement score of engineering students in electrical science.
2. Find out the influence of gender on the mean achievement score of engineering students in electrical science.

Research Questions

The following research questions were formulated to guide the statistical analysis:

1. What is the effect of digital instructional material and analogue instructional material on the mean achievement score of engineering students in electrical science?
2. What is the influence of gender on the mean achievement score of engineering students in electrical science?

Hypotheses

To carry out the statistical analysis, the following hypotheses were formulated and tested at 0.05 level of significant ($P<0.05$):

1. There is no significant difference in the mean achievement scores of engineering students taught electrical science using digital instructional material and those taught electrical science using analogue instructional material.
2. There is no significant influence of gender on the mean achievement score of engineering students in electrical science?

Method

The study was carried out in south-east zone of Nigeria. Population of the study was all national diploma engineering students in the polytechnics in the south-east zone. A sample size of two hundred and sixty four (264) engineering students was purposively drawn from two polytechnics of different States.

The two polytechnics were randomly chosen to form experimental and control groups respectively. The researchers trained the lecturers that teach electrical science in the sampled polytechnics on a quasi-experinment for the study. In the quasi-experiment that lasted for a semester (four months) the experimental and control groups were subjected to pre-test and post-test. The post-test took place after the experimental group and the control group were taught with digital instructional material and analogue instructional material respectively.

The instrument used for data collection was Students' Achievement Test on Electricity (SATE) developed by the researchers. SATE was a 50-item 4-option multiple choice objective test for achievement. Kuder-Richardson Formula 20 (K-R-20) was used to calculate the Reliability Co-efficient of the instrument by using 48 national diploma engineering students of a polytechnic located in a State in the south-east zone different from the sampled polytechnics. The reliability co-efficient of the instrument was 0.89. The data provided by the SATE was used for the statistical analysis needed. The research questions were answered using mean and standard deviation. The hypotheses were tested at 0.05 level of significance using analysis of covariance (ANCOVA).

Results

The data collected in the study were analysed and presented in tables based on the two research questions and two hypotheses that guided the study.

Research Question one: What is the effect of digital instructional material and analogue instructional material on the mean achievement score of engineering students in electrical science?

Table 1: Mean achievement scores and standard deviation of engineering students in electrical science

Instructional material type	**No of engineering students**	**Pre-test**		**Post-test**		**Mean gain**	**Mean gain difference**
		$\overline{X}$	SD	$\overline{X}$	SD		

Analogue	130	10.36	3.26	24.52	3.28	14.16	4.95
Digital	134	10.29	3.09	29.40	2.43	19.11	

The results in table 1 shows that the mean achievement score of 130 students taught with analogue instructional material increased from 10.36 with standard deviation of 3.26 to 24.52 with standard deviation of 3.28 in the pre-test and post-test respectively; thus a mean gain of 14.16 was obtained., The mean achievement score of the 134 students taught with digital instructional material increased from 10.29 with standard deviation of 3.09 to 29.40 with standard deviation of 2.43 in the pre-test and post-test respectively; resulting to a mean gain of 19.11. The mean gain difference obtained from the two mean gains was 4.95.

Research Question two: What is the influence of gender on the mean achievement score of engineering students in electrical science?

Table 2: Mean achievement scores and standard deviation of engineering students with reference to gender

Gender	**N**	**Pre-test**		**Post-test**		**Mean gain**	**Mean gain difference**
		$\overline{X}$	SD	$\overline{X}$	SD		
Male	169	10.29	3.02	26.85	3.48	16.56	0.20
Female	95	10.36	3.32	27.12	4.03	16.76	

The results in table 2 shows that the mean achievement score of 169 male students used in the study increased from 10.29 with standard deviation of 3.02 to 26.85 with standard deviation of 3.48 in the pre-test and post-test respectively, which resulted to mean gain of 16.56. For the 95 female students used in the study, the mean achievement scores increased from 10.36 with standard deviation of 3.32 to 27.12 with standard deviation of 4.03 in the pre-test and post-test respectively, which resulted to mean gain of 16.76. The values of the two mean gains indicated that the mean gain difference was 0.20, which indicated that there is little gap in the mean gain of male and female students.

Hypothesis one: There is no significant difference in the mean achievement scores of engineering students taught electrical science using digital instructional material and those taught electrical science using analogue instructional material.

Table 3: Analysis of covariance (ANCOVA) of mean achievement score of polytechnic national diploma engineering students based on instructional material group and gender

Source	Type III sum of squares	Df	Mean square	F	Sig.	Decision
Corrected model	2238.215a	3	559.554	109.292	0.000	
Intercept	2891.929	1	2891.929	564.853	0.000	
Pretest	778.961	1	778.961	152.147	0.000	
Group	1477.078	1	1477.078	288.504	0.000	Significant
Gender	2.849	1	2.849	0.556	0.456	Not significant
Error	1228.749	260	5.120			
Total	66091.000	264				
Corrected Total	3466.963	263				

a. R squared = 0.646 (Adjusted R squared = 0.640)

Table 3 shows that the F value of 288.504 in respect of instructional material group is significant at 0.000 level, and so was significant at 0.05 level. Since the probability value of 0.000 is less than the level of significance set at 0.05, the null hypothesis was not accepted. Therefore, there was significant difference in the mean achievement scores of the engineering students taught electrical

science using digital instructional material and those taught electrical science using analogue instructional material.

Hypothesis two: There is no significant influence of gender on the mean achievement score of engineering students in electrical science

Table 3 shows that F value of 0.556 in respect of gender is significant at 0.456 level, indicating that it was not significant at 0.05 level of significance. Since the probability value of 0.456 is more than the level of significance set at 0.05, the null hypothesis was accepted. Therefore, there was no significant influence of gender on the mean achievement scores of engineering students in electrical science.

Discussion

Table 1 shows that the use of digital instructional material and analogue instructional material resulted to an increase in mean achievement score of engineering students in electrical science. However, the use of digital instructional material was more efficacious than the standard analogue instructional material in increasing the mean achievement score. Table 3 further shows that there was a significant difference in the mean achievement scores of engineering students taught electrical science using digital instructional material and those taught electrical science using analogue instructional material. The higher achievement scores by engineering students taught with digital electric device could be attributed to the ease in display of numerical values which probably captured the interest of the engineering students, thereby helping them concentrate in their learning of current electrical science. The finding of this study is in line with the finding of Nwoye and Nwosu (2018) that use of locally-made digital instructional material helps physics students obtain high achievement scores compared with the achievement scores obtained using standard analogue instructional material.

The result in table 2 showed that female engineering students had a higher mean achievement score than their male counterparts; but the difference in the mean achievement score is not much. Further statistical analysis using Analysis of Covariance (ANCOVA) in table 3 showed that there was no significant difference in the mean achievement score of male and female engineering

students in electrical science. That showed that the higher mean achievement score accrued to female students might be due to chance factor. The result of this study indicates that the digital instructional material is gender-friendly in fostering engineering students' achievement in electrical science. The result obtained from this study is in agreement with the findings of Oladejo, Olosunde, Ojebisi and Isola (2011) that there was no significant effect of gender on students' achievement in physics; although, female physics students did better than males.

Conclusion

Statistical analysis on the effect of digital instructional material on achievement showed that the instructional material has more potential than analogue instructional material in enhancing engineering students' learning of electrical science. It was found that the digital instructional material is a gender-friendly device, and so it can be used in teaching of current electricity to both male and female engineering students.

Recommendations

Based on the findings of the study the followings are recommended:

1. Lecturers and students in engineering should have sound knowledge on production of locally-made digital instructional material in case there is shortage or scarcity of standard/foreign digital instructional material.
2. Lecturers and students in engineering should have high interest in the use of digital instructional material in engineering education.
3. Government and educational administrators should ensure availability and effective utilization of digital instructional material in the polytechnic education system.

References

Achor, E.E.; Taangahar, B.A. & Musa, S.A. (2011). Relative efficiency of the use of improvised and manufactured analogue voltmeters in the teaching of voltage measurements in secondary school physics. *African Journal of Science Technology and Mathematics Education, 1* (1), 87 - 97.

Akunna, O.A. & Onwubumpe, B.N. (2019). Ensuring ethics in mathematics programme for enhancement of science and technology. *Oko Journal of Science, Arts and Technology,1* (maiden edition), 400 – 404.

Egbo, J.J.B. (2014). Effect of inquiry role approach on students' achievement and retention in chemistry in Enugu State. *Unpublished Ph.D thesis, Enugu State University of Science and Technology, Enugu.*

Mbonu, B.U. (2018). Comparative effects of blended and non-blended learning strategies on students' achievement in basic science. *African Journal of Science, Technology and Mathematics Education, 4* (1), 132 – 140.

Mboto, F.A., Ndem, N.U. & Stephen, U. (2011). Effects of improvised materials on students' achievement and retention of the concept of radioactivity. *African Research Review, 5* (1), 342 – 353.

Nwosu, F.C., Odigwe, F.O. & Nwoye, A.N. (2015). Embarking on improvisation in current electricity for exposure of physics students to digitalization for sustainable development. *International Journal of Advanced Studies in Ecology, Development and Sustainability, 3* (1), 171 – 179.

Nwosu, F.C., Oguagbaka, S.K., & Akunna, O.A. (2015). Impact of mathematics in electronics useful in provision of security needed in democratic society. *International Journal of Advanced Research in Statistics, Management and Finance, 3* (1), 90 - 100.

Nwoye, A.N. & Nwosu, F.C. (2018). Assessment on efficacy of locally-made digital instructional material on achievement of physics students on current electricity. *Journal of Physical Science and Innovation, 10* (2), 43 - 61.

Okeke, A.O. (2011). Improvisation of instructional materials. *Europeans Journal of Humanities and Social Sciences, 2* (1), 321 – 328.

Okoro, I.F. & Ali-Okoro, O.C.M. (2016). Information and communications technology (ict) and curriculum implementation. In R.K. Okoye, C.V. Eze & M.V. Oluwole (Eds). *Information and communication technology and education in Nigeria: challenges and prospects*. Onitsha: Global Academic Group Online Academic Resources.

Oladejo, M. A., Olosunde, G. R., Ojebisi, A. O. & Isola, O. M. (2011). Instructional materials and students' academic achievement in physics: some policy implications. *European Journal of Humanities and Social Sciences, 2* (1), 112 – 126.

Onasanaya, S.A. & Omosewo, E.O. (2011). Effect of improvised and standard instructional materials on secondary school students' academic performance in physics in Ilorin, Nigeria. *Singapore Journal of Scientific Research, 1* (1), 68 - 76.